MARCH 1960

Radio-Electronics

HUGO GERNSBACK, Editor

phones for Small Boats

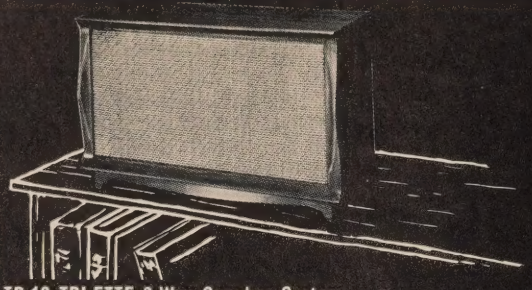
ectronics Controls
Melting Glass

ake Your Own
Solar Cells

ow Good Are Speaker
Response Curves?

KITS FOR
TURNTABLES
AND ARMS

BOB G MAHRENHOLZ 4-63
624 CIRCLE DRIVE
TULAHOMA TENN



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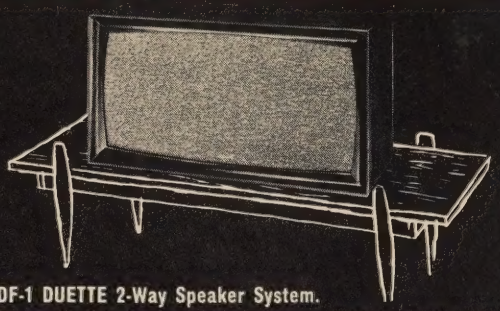

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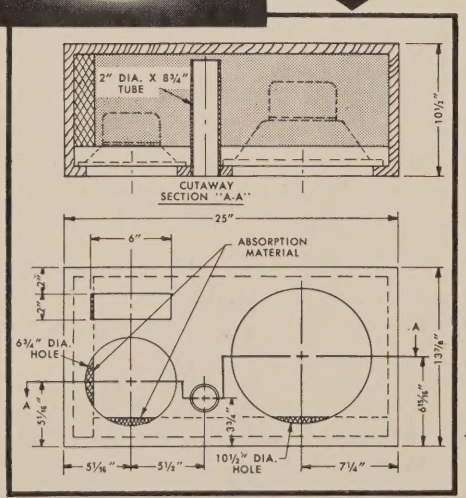

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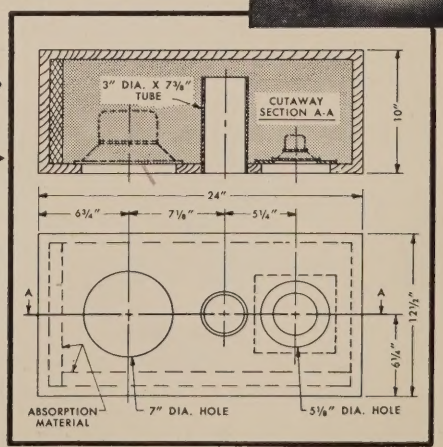

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EDITORIAL

33 Brain an Electric Computer—David Stafford-Clark

RADIO

34 Small-Boat Radiotelephones—Elbert Robberson
38 Miniature Front End for FM Receivers—E. D. Lucas, Jr.
39 FM Sensitivity Switches
40 Build This Transistor Auto Radio—A. V. J. Martin

WHAT'S NEW

43 Pictorial Reports of New Developments

AUDIO-HIGH FIDELITY

44 Turntables and Pickup Arms Built from Kits—Charles B. Graham
46 Cityrama—Multilingual Tourist Bus
47 New Developments in Audio Circuits—Robert F. Scott
49 Lows Are Directional Too
50 How Valid Are Speaker Response Curves—George L. Augspurger
54 Design Your Own Preamp, Part III—Norman H. Crowhurst
56 Feed TV Audio Into Hi-Fi Systems—George B. Leonard
57 New Discs and Tapes, Stereo and Mono—Reviewed by Chester L. Santon

INDUSTRIAL ELECTRONICS

58 Electronics Controls Level of Molten Glass—Murray Barlowe
59 How Leak Detectors Work
60 Audio Generator for Industrial Service Jobs—William F. Kernin
62 Photoelectric Control Made Easy—R. L. Winklepleck

TEST INSTRUMENTS

63 Universal 2-Terminal Oscillator—Paul S. Lederer
64 That Versatile Electron-Ray Tube—John Potter Shields
66 Mini-capacitance Test Set—David Stone
71 Handy Cable Checker—Warren J. Smith

ELECTRONICS

72 Electronic Flare Flashes Warning Signals—Edwin N. Kaufman
74 What's With Characteristic Impedance—Robert G. Middleton
76 Electronics in the Classroom—Sol D. Prensky
89 How To Make Solar Cells—D. M. Chapin

TELEVISION

95 Licking the Intermittents—Lyman E. Greenlee
109 How to Retouch, Repair, Refinish Cabinets—Jeff Markell
114 TV Service Clinic—Conducted by Jack Darr

140	Business and People	130	New Tubes and Semiconductors
18	Correspondence	6	News Briefs
146	New Books	136	Noteworthy Circuits
144	New Literature	124	Technicians' News
128	New Patents	142	Technotes
119	New Products	133	Try This One
		132	50 Years Ago

ON THE COVER

(Story on page 44)

Parts of ten kit arms and turntables arranged by Art Director Ehrlich into an interesting abstraction. Components arm is center; Audax left; Gray right. Upper right motor used in Gray, Rek-O-Kut tables; motor below it is Weathers.

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News Briefs

Machine Talks Back

A computer at the University of Toronto conversed about the weather with a human after being fed a 300-word vocabulary and 350 "frame" sentences, each with spaces left for key word fill-ins.

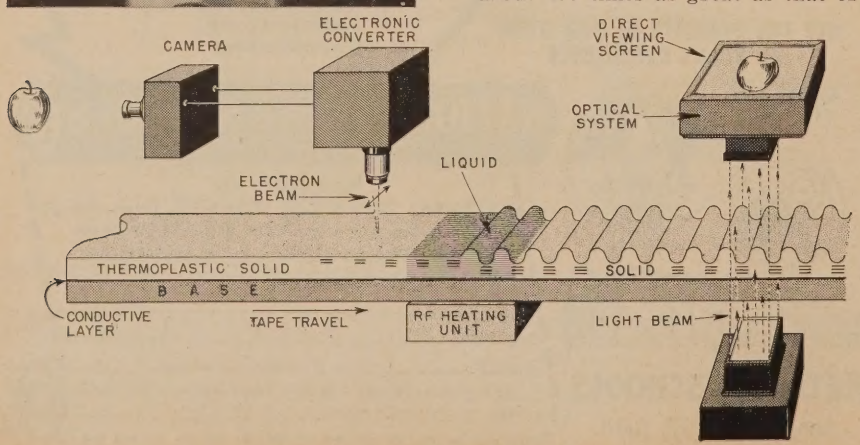
After being told at the beginning of the conversation that it was cloudy, the machine was later told by the man that it was a clear day. The IBM 650 computer answered at that point, "Let me have no lying. It becomes none but tradesmen. How can overcast weather and the clear day you mention coexist?"

[*Pravda* speaking?—*Editor*]

Experts predict that within 10 years these machines will be so skilled in conversation that no outsider will be able to detect whether a machine or a human is composing the answers.

Thermoplastic Recording

A revolutionary recording method developed by G-E scientist W. E. Glenn combines some advantages of film with the instantaneous playback and reusability of magnetic tape. G-E showed a system recording TV pictures from a standard TV set and played them back through a device similar to a 16-mm movie projector.



The recording medium is a tape that looks a lot like movie film. It has three layers, an ordinary base on which has been deposited a very thin metallic conducting layer (transparent), and over that a thermoplastic film which melts at relatively low temperatures. This surface is "written on" by an electron gun which scans it horizontally, depositing negative electric charges in accordance with the signal. Film movement, 5 or 10 inches per second, provides vertical scan.

After the tape passes under the electron gun the top layer of the tape is softened instantaneously by an rf heater. The attraction of the negative charges for the grounded or positive conducting layer below now creates ridges and valleys as the negative charges on the surface try to move closer to the opposite charge below. The stronger the charge at any given point the deeper the valley. The plastic hardens quickly, freezing the signal deformations.

The whole recording process takes about 1/100 second, and playback through an optical diffraction grating system is instantaneous. One commercial drawback is that the recording system operates in a vacuum.

Playback may also use a photocell to give an electrical output. With light on the film at the right angle, the recording becomes visible to the eye. A specimen is shown in the photograph here, with a paper clip for scale.

The information-carrying density of the new method is said to be about 100 times as great as that of equivalent area of magnetic tape.

While G-E officials said, "Considerable work must be still done before commercially practical equipment can be made available for commercial markets," others guessed it would be at least 2 to 5 years before anything practical could be seen.

Boating Electronics Up

If the recent Boat Show at the New York Coliseum is any indication, the well-equipped weekend boatsman will have at least one piece of electronic gear on board this summer. For the small boat with outboard there are portable radiotelephones, all-transistor depth finders (100-foot depth range lets the fisherman find the fish before he drops anchor), radio-direction finders, and Citizens-band radio gear.

The owner of the larger boat has even more to choose from. As well as larger versions of the portable gear for the small boat there are fuel-vapor detection units, rudder-position indicators, converters, battery chargers and electronic automatic pilots.

This upswing in electronic equipment for the boat owner obviously means more service business for the electronic technician.

Transoceanic "Waveguide"?

An elevated atmospheric duct which may carry TV frequencies with little distortion and at low loss has been found to exist at about 5,000 feet over the South Atlantic ocean, according to Air Force and Navy scientists.

Meteorological studies had predicted that such semipermanent atmospheric ducts existed, and results of first experiments not only prove there is one between South America and Africa, but that there are probably others between California and Hawaii, Cape Verde (Africa) and Puerto Rico, and Australia and the Philippines.

Satellite Relay

Balloon satellite try will be made with cooperation of the French Committee for Space Research in an attempt to use a US-launched 100-foot balloon as a reflector to beam high-frequency signals between US and France. It is now anticipated that this first attempt will place the artificial satellite about 600 miles above the earth. (See also RADIO-ELECTRONICS, December, 1959, pages

(*Continued on page* 10)

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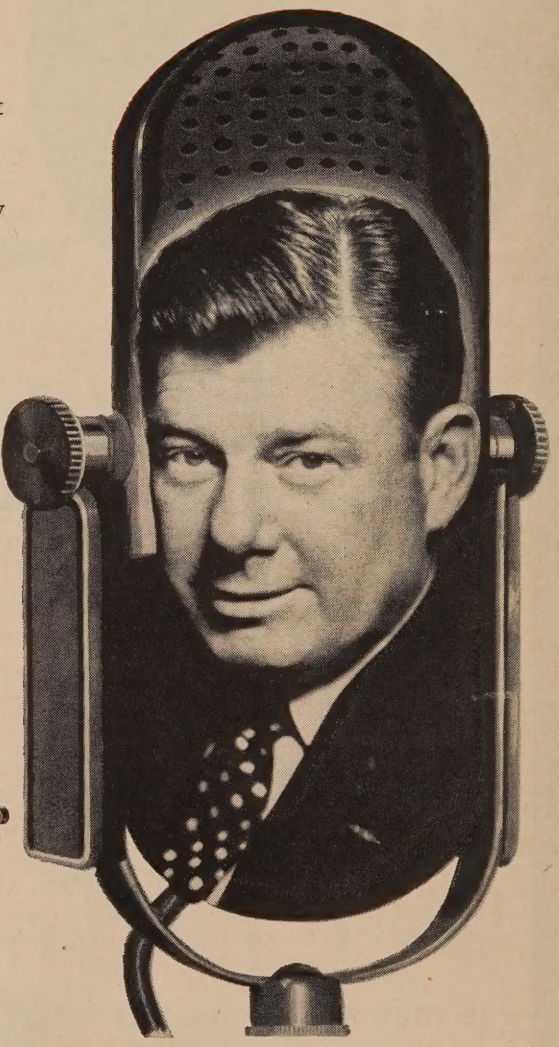

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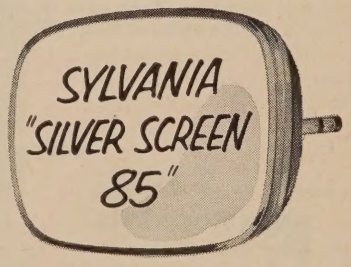

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TELECTRO

Ask to see the five great TELECTRO tape decks and the complete line of Telectro design-mated tape preamplifiers at your high fidelity dealer, or write for full information Dept.

a product of **TELECTROSONIC CORPORATION**
35-18 37th St., Long Island City 1, N. Y.

NEWS BRIEFS *(Continued from page 6)*

10, 54, and March, 1958, pages 33, 125.)

Figures Camera Angles

TV bloopers can be eliminated for under a third of a million dollars (in case you own a TV station) by installing three videotape recorders altered to incorporate a time-delay scheme similar in many respects to the tape loop used in some setups to produce audio echoes.

An electrical engineer, H. H. Hume, of Brooklyn, N. Y., has patented a system which would record views from two or three cameras on videotapes, give the TV directors several seconds in which to choose the best camera angle to present to viewers or, if necessary, cut the program off the air before objectionable material is transmitted.

Mr. Hume worked out the scheme because he was a Dodger baseball fan (when the team was in Brooklyn, anyhow) who was annoyed at missing the fast throw to third when the TV cameraman thought it was going to first!

Educational Stratovision

Stratovision plan got official FCC approval to operate from a base at Purdue University, Indiana, for the school year 1960–61, with experimental TV transmissions via airplane relay. Described in RADIO-ELECTRONICS, December, 1959, and October, 1945, the plan calls for beaming programs to a circling plane on unused TV channels, for rebroadcasting to a ground area with a radius of about 150–200 miles.

Two simultaneous transmissions of the educational programs will be made to compare the results using a 6-mc bandwidth with 3 mc. Ten schools will be set up with regular and narrow-band receivers for the 1-year test period. Transmitters on the ground and in the DC-7 will use peak power of 12 kw.

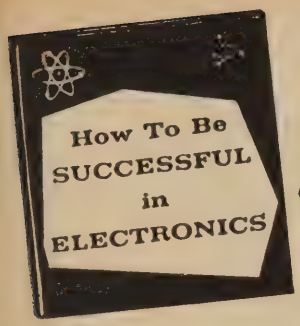
New Voice for America

Almost 5 megawatts will be the total transmitter power for the Voice of America's consolidated East Coast facilities to be started near Greenville, N. C., soon. Two mammoth transmitter installations and a receiving station will be spaced around an 18-mile triangle to eliminate mutual interference.

Several presently scattered VOA installations will be concentrated at Greenville to beam programs overseas with six 500-kw, six 250-kw and 10 lesser-powered transmitters. They'll use almost a hundred rhombic, curtain and log periodic antennas requiring 400 towers from 50 to 375 feet high.

Electronics Goes Fishing

Going fishing will be even less work in the future, due to electronics which attract fish into a large tube



FREE

tells how

Get your FCC Commercial License —or your money back

The Master Course in Electronics will provide you with the mental tools of the electronics technician and prepare you for a First Class FCC License (Commercial) with a radar endorsement. When you successfully complete the Master Course, if you fail to pass the FCC examination, you will receive a full refund of all tuition payments.

EFFECTIVE JOB FINDING SERVICE HELPS CIRE TRAINEES GET BETTER JOBS

"License and $25 raise due to Cleveland Institute Training"

"I sat for and passed the FCC exam for my second class license. This meant a promotion to Senior Radio Technician with the Wyoming Highway Department, a $25 a month raise and a District of my own for all maintenance on the State's two-way communication system. I wish to sincerely thank you and the school for the wonderful radio knowledge you have passed on to me. I highly recommend the school to all acquaintances who might possibly be interested in radio. I am truly convinced I could never have passed the FCC exam without your wonderful help and consideration for anyone wishing to help themselves."

CHARLES C. ROBERSON
Cheyenne, Wyoming

HERE'S PROOF FCC LICENSES ARE OFTEN SECURED IN A FEW HOURS WITH OUR COACHING

Name and Address	License	Time
John H. Johnson, Boise City, Okla.	1st	20 weeks
Prentice Harrison, Lewes, Delaware	1st	27 weeks
Herbert W. Clay, Phoenix, Arizona	2nd	22 weeks
Thomas J. Bingham, Finley, North Dakota	2nd	9 weeks
William F. Masterson, Key West, Fla.	2nd	24 weeks

EMPLOYERS MAKE JOB OFFERS LIKE THESE TO OUR GRADUATES EVERY MONTH

Employers Make Job Offers Like These To Our Graduates Every Month

Broadcast Station in Illinois: "We are in need of an engineer with a first class phone license, preferably a student of Cleveland Institute of Radio Electronics; 40 hour week plus 8 hours overtime."

West Coast Manufacturer: "We are currently in need of men with electronics training or experience in radar maintenance. We would appreciate your referral of interested persons to us."

Cleveland Institute of Electronics
RE 39 B, 4900 Euclid Bldg., Cleveland 3, Ohio

Your FCC Ticket is recognized by employers as proof of your technical ability.

Accredited by National Home Study Council

Please send Free Booklets prepared to help me get ahead in Electronics.
I have had training or experience in Electronics as indicated below:

☐ Military ☐ Amateur Radio ☐ Telephone Company
☐ Radio-TV Servicing ☐ Broadcasting ☐ Other .....
☐ Manufacturing ☐ Home Experimenting

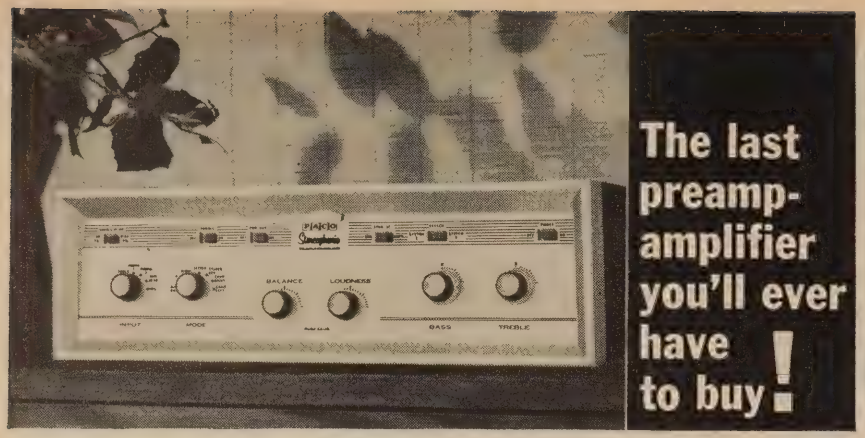
In what kind of work are you now engaged?.....

In what branch of Electronics are you interested?.....

Name .....Age .....Address .....

City .....Zone .....State .....

RE39B



A new 40-watt stereo preamp-amplifier in kit form for only $79.95 by

PACO

also available factory wired for $129.95

PACO is the kit division of ***PRECISION*** Apparatus Co., Inc., world famous manufacturers of laboratory electronic instruments for over a quarter century. The new Model SA-40 is the first of a series of component high fidelity kits from PACO...engineered for utmost performance and lasting value—designed for maximum eye-appeal.

Whether you're an experienced audiophile or a newcomer to the thrill of high fidelity, the factors you must consider in choosing the amplifier you need are: POWER, DISTORTION, FLEXIBILITY and VALUE.

The PACO SA-40 offers you greater reserve power capacity than any other preamp-amplifier in its category. Its exceptional circuit design assures highly stable performance with extremely low distortion. Step-by-step assembly instructions and giant-size wiring diagrams are so clearly detailed and simple that the technical difference between expert and novice disappears. And...the SA-40 provides maximum flexibility in *any* stereophonic high fidelity system...present or contemplated.

For those interested in engineering details, some of the more important technical specifications are listed below:

POWER OUTPUT:
Steady State Power Output: 20 watts per channel, 40 watts total.
Music Waveform Power Output: 25 watts per channel, 50 watts total.
Peak Power Output: 40 watts per channel, 80 watts total.
RESPONSE: 30 cps to 90 Kc, ± 1.0 db.
DISTORTION:
Harmonic: Less than .2% at 20 watts per channel output. Less than .1% at 10 watts per channel output.
Intermodulation: Less than 1% at full rated output.
FRONT PANEL CONTROLS AND SWITCHES: 14 controls including separate bass and treble controls for complete flexibility with any monophonic or stereo program source.
INPUTS: 14 total; 3 dual high-level and 4 dual low-level.
OUTPUTS: Dual tape outputs, separate preamp output as well as standard dual speaker outputs.
HUM AND NOISE LEVEL:
High Level Input: 80 db below rated output.
Low Level Input: 70 db below rated output.
Tape Input: 65 db below rated output.
SPEAKER CONNECTIONS: 4, 8, 16, 32 ohms.
SENSITIVITY FOR RATED OUTPUT:
Aux Input: .75 V **Phono 1:** (Magnetic) 5 Mv.
Tuner: .75 V **Phono 2:** (Magnetic) 5 Mv. or Ceramic .3 V
INVERSE FEEDBACK: 25 db
DAMPING FACTOR: 22
BASS TONE CONTROL RANGE: ±15 db at 50 cps.
TREBLE TONE CONTROL RANGE: ±15 db at 10 Kc.
RUMBLE FILTER: 6 db per octave below 50 cps.
EQUALIZATION: Phono: "RIAA"; "EUR"; Tape: 3¾ and 7½ ips, NARTB
TAPE OUTPUT LEVEL: 2 volts per channel.
POWER SUPPLY: Silicon diode, low impedance for minimum distortion on extended high level passages.
EXTERNAL DESIGN: Gold and satin black hooded case, with panel illumination and satin gold panel.
DIMENSIONS: 15⅜" wide x 11¾" deep x 5⅝" high
Model SA-40: Complete with case and step-by-step assembly-operating manual ..... **Kit Net Price $ 79.95**
Model SA-40W: Factory Wired .... **Net Price $129.95**

Ask your own Audio-Radio-TV Serviceman about PACO and PRECISION products. He'll tell you that they always live up to their specs. That's why we can say that the PACO SA-40 is the last preamp-amplifier you'll ever have to buy

Available at leading electronic parts distributors and wherever good sound is sold.

For complete information write to:

PACO

Electronics Co., Inc.
70-31 84th Street
Glendale 27, L. I., N. Y.

A Division of
PRECISION
Apparatus Company, Inc.

Export:
Morhan Exporting Corp.
458 Broadway
N. Y. 13, N. Y., U.S.A.

Canada:
Atlas Radio Corp., Ltd.
50 Wingold Ave.
Toronto 19, Ontario

NOW AVAILABLE—MODEL ST-45
AM/FM STEREO TUNER KIT
matching companion
for the SA-40

lowered into the water. A few kilowatts of current are pulsed periodically, pulling in all fish within a 10-yard radius. A light is used to attract them from greater distance.

So far, herring and sardines have been caught with the equipment on trawlers in the North Sea. It's been found that different kinds of fish respond to different voltages. Work was done by Herr J. Dethloff, director of the International Electronics Laboratories, Hamburg, Germany.

New Radar Has Long Reach

Long range radar MADRE uses *MA*gnetic *D*rum *R*eceiving *E*quipment to preserve transmitted pulses, compare them with returning pulses to extend radar range out to 500 to 2,600 miles, depending on atmospheric conditions.

Low frequencies (3–30 mc) and relatively low powers averaging only 100 kw are beamed by huge fixed antennas, a typical one being 330 feet long and 150 feet high.

Mars Technical Net

Schedule for March will present "Transistorized Test Equipment for the Amateur Station," Bob Gunderson, W2JIO, Braille Technical Press —March 2; "Fundamental Requirements for Military SSB Receiver Design," Dudley Kahn, Signal Corps —March 9; "Low Noise Preamplifiers," Dr. James W. Meyer, MIT Lincoln Labs—March 16; "Fundamentals of Single Sideband and Some Commercial Practice," S. Edwin Piller, Radio Engineering Labs—March 30.

The First Army MARS (Military Affiliate Radio System) SSB Network passed its second birthday in January this year. The net operates in the northeastern part of the United States.

Two TV Starters

Two new TV stations started with the new year:

KDSJ-TV, Deadwood, S. D..... 5
KNBS, Walla Walla, Wash...22

KDSJ-TV is a satellite of KRSD-TV, Rapid City, S. D., channel 7.

There were two changes in call letters:

KCPX-TV, Salt Lake City, Utah 4
(formerly KTVT)
KVER-TV, Clovis, N. M.....12
(formerly KICA)

The US tally of operating stations is up to 567, including 474 vhf and 93 uhf. The noncommercial figure remains 43.

Canada has opened its third French-language outlet:

CBAFT, Moncton, N. B.....11

Its total thus moves up to 59.

Improved Radar

River radar requirements have produced improved short-range radars with seven graduated ranges,

1. Also: Let It Rain, Stairway to the Sea, Flame of Love, etc.

5. A Night on Bald Mountain, Steppes of Central Asia, etc.

6. Bess, You Is My Woman Now; It Ain't Necessarily So; etc.

17. Over the Rainbow, Night and Day, Easy to Love, 9 more

34. "... the music is all extraordinary" —Boston Daily Record

33. This brilliant musical painting is an American classic

10. A brilliant new performance of this popular concerto

13. But Not for Me, Fascinatin' Rhythm, Man I Love, 9 more

2. 1001 hi-fi delights. "...top-notch sound" — Billboard

9. Sweet Adeline, For Me and My Gal, Pretty Baby, 13 more

15. An exciting array of 16 classical and popular selections

18. Rain in Spain, I Could Have Danced All Night, etc.

COLUMBIA (Lp) RECORD CLUB offers new members

ANY SIX

of these 12" long-playing STEREO records

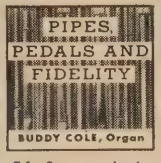
FOR ONLY $4.98

Retail Value up to $35.88.

if you join the Club now and agree to purchase as few as 5 selections from the more than 150 to be made available during the coming 12 months

11. Also: Blessed Are They That Mourn, Come Ye Saints, etc.

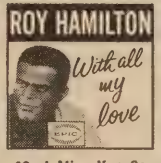
24. "Musical excitement that's hard to beat" — Variety



56. Serenade in Blue, Willow Weep for Me, 9 others

3. Stella by Starlight, Pacific Sunset, Yesterdays, 9 others

25. Superbly played by one of Europe's finest orchestras



40. I Miss You So, Speak Low, Time After Time, 9 more

36. A musical landscape . . . "spacious, noble" —High Fidelity

26. Blue Moon, Fools Rush In, Don't Worry 'bout Me, 9 more

47. Solitude, Where or When, Dancing in the Dark, 5 more

49. One of the most melodically beautiful of all symphonies

30. Alexander's Ragtime Band, Cheek to Cheek, Always, etc.

19. Tales from the Vienna Woods, Blue Danube, 8 others

12. Londonderry Air, Shenandoah, 11 more folksong favorites

22. "Enormous talent and technique" — Chicago News

4. Wild Man Blues, Fine and Mellow, I Left My Baby, 5 more

37. "Most exciting recording of this work" —Time

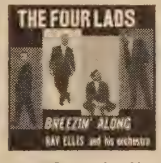
14. "No symphony like it . . . incomparable" — Olin Downes

7. One Kiss, Will You Remember, Song of Love, 9 more

29. Three of the Master's favorite chamber works

31. You've Changed, Body and Soul, I Got It Bad, 9 others

35. "One of the great, great albums" —San Francisco Examiner



50. Come to Me, That Old Feeling, Long Ago, 9 more

8. "Beautiful...lingering brilliance" — Chicago Tribune

39. Tico-Tico, My Shawl, Besame Mucho, 9 others

AN EXCITING NEW OFFER FROM THE WORLD'S LARGEST RECORD CLUB

If you now own a stereo phonograph, or plan to purchase one in the near future—here is a unique opportunity to obtain ANY SIX of these brand-new stereo records for only $4.98!

TO RECEIVE 6 STEREO RECORDS FOR $4.98 — fill in and mail the coupon now. Be sure to indicate which one of the Club's two musical Divisions you wish to join: Stereo Classical or Stereo Popular.

HOW THE CLUB OPERATES: Each month the Club's staff of music experts selects outstanding recordings from every field of music. These selections are described in the Club's entertaining Music Magazine, which you receive free each month.

You may accept the monthly selection for your Division, take any other records offered (classical or popular), or take NO record in any particular month.

Your only obligation as a member is to purchase five selections from the more than 150 Columbia and Epic records to be offered in the coming 12 months . . . and you may discontinue your membership at any time thereafter.

FREE BONUS RECORDS GIVEN REGULARLY: If you wish to continue as a member after purchasing five records, you will receive a Columbia or Epic stereo Bonus record of your choice free for every two selections you buy — a 50% dividend.

The records you want are mailed and billed to you at the regular list price of $4.98 (Classical and Original Cast selections, $5.98), plus a small mailing and handling charge.

MAIL THE COUPON TODAY!

NOTE: Stereo records must be played only on a stereo phonograph

COLUMBIA (Lp) RECORD CLUB Terre Haute, Indiana

SEND NO MONEY — Mail coupon to receive 6 stereo records for $4.98

COLUMBIA (Lp) RECORD CLUB, Dept. 212-8
Stereophonic Section, Terre Haute, Indiana

I accept your offer and have circled at the right the numbers of the six records I wish to receive for $4.98, plus small mailing and handling charge. Enroll me in the following Division of the Club:

(check one box only)

☐ **Stereo Classical** ☐ **Stereo Popular**

I agree to purchase five selections from the more than 150 records to be offered during the coming 12 months, at regular list price plus small mailing and handling charge. For every two *additional* selections I accept, I am to receive a 12" Columbia or Epic stereo Bonus record of my choice FREE.

Name.....
(Please Print)
Address.....
City.....ZONE....State.....

ALASKA and HAWAII: write for special membership plan
CANADA: address 1111 Leslie St., Don Mills, Ontario

If you want this membership credited to an established Columbia or Epic record dealer, authorized to accept subscriptions, fill in below:

Dealer's Name.....
Dealer's Address.....21

CIRCLE 6 NUMBERS:

1	13	31
2	14	33
3	15	34
4	17	35
5	18	36
6	19	37
7	22	39
8	24	40
9	25	47
10	26	49
11	29	50
12	30	56

P-BC

® "Columbia," (Lp) "Epic," ℗ Marcas Reg. © Columbia Records Sales Corp., 1960

one word more about the

Amperex®
6CA7/EL34
OUTPUT PENTODE

NOW ITS RATED POWER OUTPUT IS 60 WATTS (Class AB_1)

We are pleased to announce that as a result of the further exploration of the 6CA7's capabilities . . . its power output rating has been raised to 60 watts in a distributed load circuit. This was achieved by increasing the screen grid voltage to 500V. The screen voltage rating now equals the plate voltage rating, thus greatly simplifying the design of power supplies.

Class AB_1 Audio Amplifier Distributed Load Connection Typical Operation
(Fixed Bias—Two Tubes Push Pull)

Plate Supply Voltage.....500 V	Harmonic Distortion.....2.5%
Grid No. 2 Supply Voltage.....(See Note) 500 V	Plate and Grid No. 2 Current (Max. Signal).....2x112 mA
Grid No. 1 Bias.....(approx.)—44.5 V	Input Signal Voltage (rms).....32 V
Plate to Plate Load Resistance....7000 Ω	Plate and Grid No. 2 Current (Zero Signal).....2x57 mA
Power Output.....60 W	

NOTE: Screen voltage is obtained from taps located at 43% of the plate winding turns. An unbypassed resistor of 1KΩ in series with each screen grid is necessary to prevent screen overload.

ask Amperex

ask your Amperex distributor about Amperex voltage amplifier, rectifier and output tubes for hi-fi circuits.

AMPEREX ELECTRONIC CORP.
230 Duffy Avenue, Hicksville, L. I., N. Y.

What the future holds for you in RADIO-ELECTRONICS

- All Transistor FM Portable
- Photoflash uses Transistors
- Improving the Twin-Coupled Amplifier
- Servicing Horizontal Sweep Circuits
- Simple Pulse Generator
- Adding Sound to 35-mm Slides

The APRIL issue of RADIO-ELECTRONICS goes on sale March 29 at all better parts distributors and newsstands.

SUBSCRIPTION RATES
1 year $4.00 2 years $7.00 3 years $10.00

RADIO-ELECTRONICS
154 West 14th Street New York 11, N. Y.

the closest of which covers objects at 440 yards. The new Decca radar also has a variable focus control which enables sharpening the picture, or eliminating unwanted "echoes."

Chicago Receiver Meeting

Papers on TV and broadcast receivers are being solicited for the Chicago Spring Conference on Broadcast and Television Receivers, sponsored by the IRE, June 20 and 21. For further information, contact Jack Bridges, Papers Chairman, c/o Warwick Mfg. Co., 7300 N. LeHigh Ave., Chicago 48, Ill.

Calendar of Events

EIA Spring Conference, Mar. 16–18, Hotel Statler, Washington, D. C.

IRE National Convention, Mar. 21–24, Coliseum & Waldorf Astoria Hotel, New York, N. Y.

Nuclear Congress, April 3–8, New York Coliseum, New York, N. Y.

Conference on Automatic Techniques, April 18–19, Sheraton Cleveland Hotel, Cleveland, Ohio.

Symposium on Active Networks and Feedback Systems, April 19–21, Auditorium of Engineering Societies Bldg., New York, N. Y.

Southwest IRE Regional Conference and Electronics Show, April 20-22, Shamrock-Hilton Hotel, Houston, Tex.

PACE Annual Meeting, April 29–May 1, Nevele Hotel & Country Club, Ellenville, N. Y.

Details on all events supplied by sponsoring organizations.

Breaks 'em up

In merrie England, a TV viewer, John L. McNally of Canterbury, fed up with 2 years of his set acting up constantly took a sledge hammer to the shop where he'd bought his receiver and smashed every set in sight. The judge agreed that he had provocation, but gave him 6 months to cool off anyhow.

John Reinartz Honored

In recognition of more than half a century as an amateur radio pioneer, followed by distinguished contributions to military and commercial communications, a testimonial banquet was tendered to John Reinartz (1QP, 1XAM and K6BJ) on Feb. 1. The testimonial coincided with Reinartz' retirement as manager of the Amateur Service Department of Eitel-McCullough, who sponsored the banquet.

Reinartz, probably one of the greatest American amateurs of all time, was known to millions in the '20's as the inventor of the almost universally used Reinartz shortwave receiver circuit. He was one of the earlier experimenters in high-frequency propagation, and with Leon Deloy of France pioneered trans-Atlantic two-way transmissions at 100 meters (3000 kc).

Learn Electronics

PREPARE FOR YOUR F. C. C. LICENSE—YOUR TICKET TO A BETTER JOB AND HIGHER PAY!

F.C.C. LICENSE—THE KEY TO BETTER JOBS

An F.C.C. *commercial* (not amateur) license is your ticket to higher pay and more interesting employment. This license is Federal Government evidence of your qualifications in electronics. Employers are eager to hire *licensed* technicians.

WHICH LICENSE FOR WHICH JOB?

The THIRD CLASS radiotelephone license is of value primarily in that it qualifies you to take the second class examination. The scope of authority covered by a third class license is extremely limited.

The SECOND CLASS radiotelephone license qualifies you to install, maintain and operate most all radiotelephone equipment except commercial broadcast station equipment.

The FIRST CLASS radiotelephone license qualifies you to install, maintain and operate every type of radiotelephone equipment (except amateur) including all radio and television stations in the United States, its territories and possessions. This is the highest class of radiotelephone license available.

GRANTHAM TRAINING PREPARES YOU

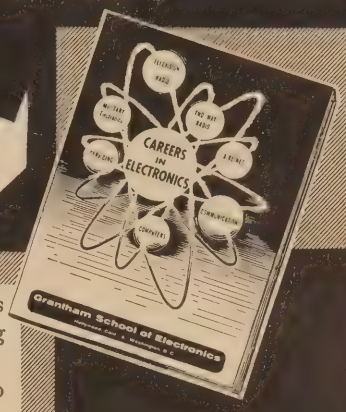
The Grantham Communications Electronics Course prepares you for a *FIRST CLASS* F.C.C. license, and it does this by TEACHING you electronics. Each point is covered simply and in detail, with emphasis on making the subject easy to understand. The organization of the subject matter is such that you progress, step-by-step, to your specific objective—a first class F.C.C. license.

CORRESPONDENCE OR RESIDENCE CLASSES

Grantham training is available by correspondence or in resident classes. Either way (residence or correspondence), we train you quickly and well—no previous training required. Even a beginner may qualify for his first class license in a relatively short time.

FOUR COMPLETE SCHOOLS: *To better serve our many students throughout the entire country, Grantham School of Electronics maintains four complete Divisions—located in Hollywood, Calif., Seattle, Wash., Kansas City, Mo., and Washington, D.C. All Divisions of Grantham School of Electronics offer the same rapid courses in F.C.C. license preparation, either by home study or in resident classes.*

This booklet **FREE!**



This free booklet gives details of our training and explains what an F.C.C. license can do for your future.

Upgrade Your Income with a First Class F. C. C. LICENSE

HERE'S PROOF...

that Grantham students prepare for F.C.C. examinations in a minimum of time. Here is a list of a few of our recent graduates, the class of license they got, and how long it took them:

	License	Weeks
Donald E. Mason, 2659 Centinella, Santa Monica, Calif.	1st	12
Everett T. Bozard, 411 N. Wash. St., Alexandria, Va.	1st	12
Henry M. Best, 1003 Vermont St., Fremont, N. C.	1st	11
Harold V. Jones, P. O. Box 705, Alamogordo, N. M.	1st	13
Michael F. Aperio, 916 Townsend St., Chester, Pa.	1st	12
Earl A. Stewart, 3918 Modesto Dr., San Bernardino, Calif.	1st	14
Donald L. Leeburg, Box 1075, Anchorage, Alaska	1st	12
J. Milton Condit, 1312 N. 78th Street, Seattle, Wash.	1st	8
John R. Bahrs, 72 Hazelton St., Ridgefield Park, N. J.	1st	12
Richard Baden, 4226 - 37th St., N.W., Washington, D. C.	1st	12
James F. Stewart, 2618½ Prospect Ave., La Crescenta, Calif.	1st	12
Norman R. Cook, 130 Olive Street, Neodeska, Kans.	1st	12

GRANTHAM SCHOOL OF ELECTRONICS

HOLLYWOOD CALIF.	1505 N. Western Ave. Hollywood, Calif. (HO 7-7727)
SEATTLE WASH.	408 Marion Street Seattle, Wash. (MA 2-7227)
KANSAS CITY MO.	3123 Gillham Road Kansas City, Mo. (JE 1-6320)
WASHINGTON D. C.	821 - 19th Street, N. W. Washington, D. C. (ST 3-3614)

MAIL COUPON TO SCHOOL NEAREST YOU

(Mail in envelope or paste on postal card)

To: GRANTHAM SCHOOL OF ELECTRONICS

1505 N. Western Hollywood • 408 Marion Seattle • 3123 Gillham Rd. Kansas City • 821-19th, NW Washington

Gentlemen:

Please send me your free booklet telling how I can get my commercial F.C.C. license quickly. I understand there is no obligation and no salesman will call.

Name_____ Age_____

Address_____

City_____ State_____

I am interested in: ☐ Home Study, ☐ Resident Classes 04-C

Centralab has the answer

to your ~~duel~~ dual control problems

FASTATCH Dual Radiohms®

No need to fence with dual concentric replacements . . . your problems are solved with CENTRALAB Model F and R controls. Just match front and rear units with proper resistance and taper—cut shafts to length (it's easy with the CENTRALAB SK-2 precision Shaft-Kut Tool)—snap together, and *touche*, you're ready to go.

You won't be foiled by switch problems, either. Just parry them by snapping on a Fastatch KR line switch if needed.

Fastatch Radiohms enable you to meet the demand for an immense variety of dual concentrics with a minimum of components. (The handy FDK-100 Kit provides coverage of 90% of your dual control requirements.) Ask your distributor for full information about CENTRALAB Model F & R controls.

CENTRALAB products are listed in PHOTOFACTS, COUNTERFACTS, and THE RADIO-ELECTRONIC MASTER.

Centralab

B-6002

ELECTRONICS DIVISION OF GLOBE-UNION INC.
900A E. KEEFE AVE. • MILWAUKEE 1, WIS.
IN CANADA: 669 Bayview Ave., Toronto 17, Ont.

CONTROLS • ROTARY SWITCHES • CERAMIC CAPACITORS
PACKAGED ELECTRONIC CIRCUITS • ENGINEERED CERAMICS

Ion Engine

A new potential source of power for space and other engines has been developed and demonstrated by NASA (National Aeronautics and Space Administration). This experimental engine uses the rare metal cesium as a propellant. The metal is vaporized and placed near tungsten strips where the reaction separates ions from the cesium. Tantalum or stainless steel electrodes near the rear of the motor then attract the freed ions, and they shoot out the rear of the engine, providing thrust.

The amount of thrust which can be developed in this way is relatively small, but NASA believes an ion engine could provide adequate thrust to propel vehicles once outside gravitational fields.

AM SSB Stereo Broadcasting

Four foreign radio stations will initiate compatible AM stereo broadcasting using the Kahn Research system soon.

The system develops two separate sidebands, one for each stereo channel, at the transmitter. Then two standard AM sets are tuned, one to the lower sideband, one to the upper. Full monophonic reception is available by simply tuning to the center of the carrier.

The stations which will use the system are in Canada, Mexico and Venezuela.

Automatic Industrial Control on the Way

An industrial computer has been running almost continually for 6 months in a severe test of industrial control equipment reliability which points toward total control of industrial operations through computer automation.

A general-purpose digital computer and associated equipment at Sterlington, La. monitors 350 temperature, pressure and flow points at a public-utility electric plant, continuously scanning them in sequence. Using the scanned information, it computes a number of variables, setting off an alarm if measured or computed values go outside preset limits. In such cases, it pinpoints the trouble spot.

This Daystrom data logger and computer uses 4,000 transistors and 7,500 diodes. Its high reliability is said to be the result of solid-state design whose operational rate is *relatively* slow, only 50 kc. Its accuracy is 1 part in 1,000,000. The next step will be a fully automated digital computer control system to be installed by Daystrom at Little Gypsy, La., where it will run a 230,000-kw utility station. It will continuously monitor 1,226 check points and automatically start, operate, shut down the generating station. END

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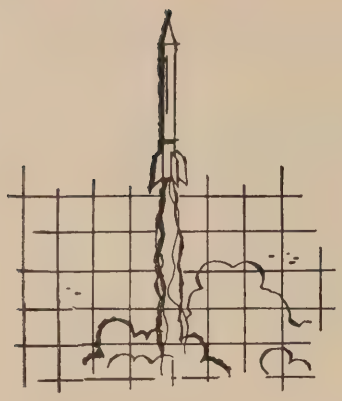

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If you are a graduate of an accredited Technical School and/or have military training in radar or communications equipment, plus at least 2 years' experience in electronics, you are invited to address your inquiries to Mr. R. F. Johnson, Department 2451, Military Field Service Division, Burroughs Drive, Radnor, Penna. (A suburb of Philadelphia).

Burroughs Corporation

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Correspondence

MORE ON 7-TRANSISTOR POCKET RADIO

Dear Editor:

We have received several inquiries as to the availability of the RCA 239S1 speaker I specified in my article "7-Transistor Pocket Radio" (November 1959, page 32–34). Unfortunately, this speaker has been discontinued. However, several imported 2-inch speakers are available through many of the larger parts distributors which should prove satisfactory. Some variation in speaker impedance can be tolerated.

Not shown on the diagram was the interlead shield (lead 3) of the 2N247 transistors. These and the shields of the if transformers should go to ground.

Due to normal production variations in other components, R4 (330,000 ohms) may have to be increased or decreased to obtain the maximum if gain commensurate with stable operation.

This table shows the terminal connections for the Miller transformers (numbers are shown on the Miller units):

T1	*T2*
1—gnd	1—not used
2—T2	2—avc
3—V1 coll.	3—V2 base
4—C1	4—T1
5—C5	5—B minus
T3	*T4*
1—not used	1—not used
2—avc	2—gnd
3—V3 base	3—D
4—V2 coll.	4—V3 coll.
5—R6	5—B minus

HAL WITTLINGER

RCA Tube Div.
Harrison, N. J.

COMMERCIAL SERVICE—ANOTHER VIEW

Dear Editor:

In the December 1959 issue of RADIO-ELECTRONICS Mr. Lester Berry stated that he would refuse to do commercial equipment service jobs in the future because of lack of cooperation from manufacturers.

I too, like Mr. Berry, have tried in vain to get parts for a NATCO 3030-1 16-mm sound projector. However, this is not a good example of lack of cooperation—the company has been out of business for a number of years.

I have been trying to get two fiber gears for this machine for over 6 months. Though this job was not very profitable, it will not cause me to quit this interesting and profitable field of service work.

I have enjoyed your articles on industrial electronics and this is one of the

(*Continued on page* 22)

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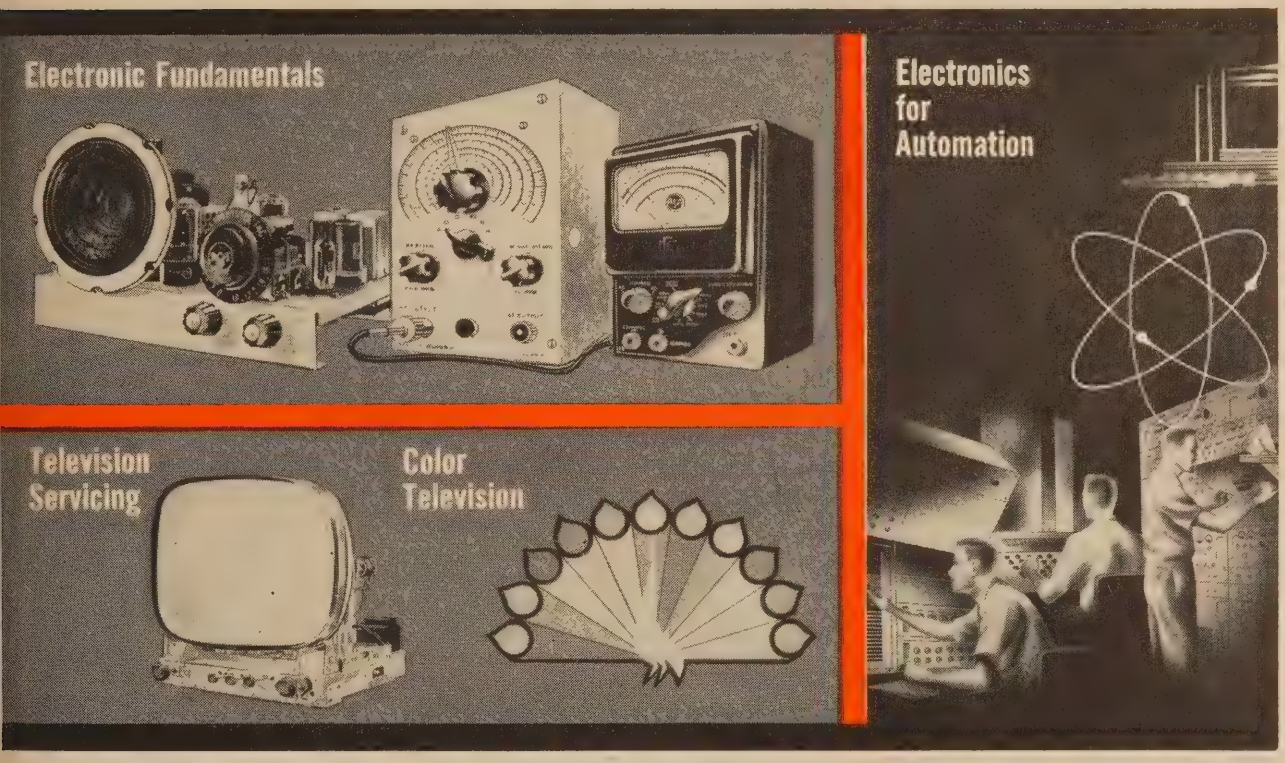

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ACE RADIO & TV SERVICE

PORTLAND · LONGVIEW · YAKIMA

[illegible] 6th Ave.
[illegible], Wash.
October [illegible], 1959

Westinghouse Electric Corp.
600 St. Paul Ave.
Los Angeles 17, California

Gentlemen:

We are constantly seeking improved products to recommend and sell to our customers, and we are pleased to inform you that Westinghouse receiving tubes and picture tubes fall into that category.

We changed over exclusively to Westinghouse tubes approximately January 1st, of this year. Since it was a new product to us, we kept complete records of tube failures and customer call backs. Our call backs due directly to tube failures were reduced by over 50 per cent.

It is with complete confidence that we recommend and sell your quality Gold Star picture tubes. The picture quality is excellent, and the tubes are exceeding our greatest expectations. In the past nine months, we have used approximately 500 picture tubes, and as of now have only replaced three. Two of which were defective out of the carton, and only one failed in actual use. In fact, we are so confident in the life of the picture tube, that we are now guaranteeing our picture tube replacements for three years.

We have earned two things by the use of your tubes. Greater customer satisfaction, and more net dollars for us through the very minimum amount of tube failures.

Please thank your Engineers and Quality Control Department for the fine product that they are putting in our hands to sell to the consumers.

Sincerely yours,

ACE RADIO & TV SERVICE

Phillip Plank

PHILLIP PLANK

[illegible]

"call backs reduced by over 50%!"

"It is with complete confidence that we recommend and sell your quality Gold Star picture tubes."

"We are so confident in the life of the picture tube that we are now guaranteeing our picture tube replacements for three years."

"We have gained...greater customer satisfaction, and more net dollars for us due to the very minimum amount of tube failures."

We can't think of a thing to add. Except, perhaps, that your local Westinghouse electronic tube distributor will be happy to introduce you to the line. If your distributor doesn't carry them yet, give us his name. We'll send someone over to enlighten the poor fellow.

YOU CAN BE SURE...IF IT'S Westinghouse

Westinghouse Electronic Tube Division, Elmira, N.Y.

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at it's VERY BEST!

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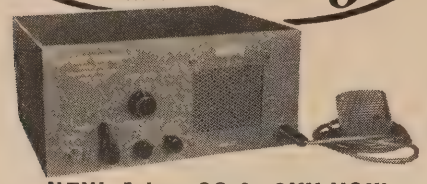
Kits and Wired



NEW Arkay SQ-9 'SKY-VOX'
Citizens' 2-Way Radio

Superhet Receiver—Crystal Controlled Transmitter

Magnificiently engineered for outstanding performance, ease of assembly and operation, the Sky-Vox offers high sensitivity, selectivity, stability and fidelity of sound.—The finest in citizens' band communication for business, pleasure, auto, farm, home, industry, etc.

Completely Wired & Aligned Front End for Easy Assembly

Advanced design features include: Completely assembled front end with 3 channels aligned ready to install in main chassis • Up-to-the-minute circuitry with 8 tubes and 5 diodes • Supersensitive crystal controlled superhet receiving circuit • Crystal controlled oscillator Pentode RF amplifier transmitting circuit • Front Panel controls include 3 position channel selector • Receive-Transmit switch • Volume control • Squelch control • Mike input • Noise balance control in rear chassis.

Power Requirements: 117 Volts 60 cycles AC or 12 Volts DC. Sensitivity: 1 u/v. 400 cy. at 27.015 Mc. for full output (2.5 Watts); Signal/Noise Better than 35 DB • Image 30 DB • IF Bandwidth 5 KC • Complete with 2 cables, microphone and set of crystals. Attractive metal case. Size: 5"Hx8½"Dx11"W.

Wired and Tested $119.95 • Easy-to-build Kit **$79.95**

the Arkay MS-5 STEREO Record Playback TAPE DECK

Professional quality at a popular price!

A supreme achievement in tape deck design and performance, the ARKAY records your favorite music with the same superb performance of tape recorders costing many times more. No other tape deck—regardless of price—offers so many important features. Here's just a few:

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- Drop-In Loading
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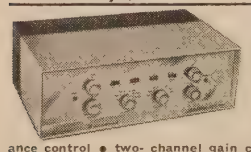
- Large (½" diam.) capstan
- Size: 12-3/16" x 14½" x 6¼".

2 Track Only $129.95 • 4 Track Slightly Higher



ARKAY CS-28 Stereo Amp/Pre-Amp Complete Control Center

Full 28 watts stereo of monaural, 60 watts peak • 14 watts each channel • reverse stereo • balance control • two- channel gain control • full-range bass and treble controls • IM distortion, 4 to 1 • harmonic distortion, 1% 30-20,000 cps • dual pre-amp 2V output jacks • speaker outputs, 4, 8, 16, 32 ohms • response, 20-20,000 cps • push-pull EL84 Williamson circuit.

Wired and tested $99.95 • Easy-to-build Kit **$64.95**

ARKAY ST-11 AM-FM STEREO TUNER

Here, for the first time, is an AM-FM STEREO Tuner within the reach of every audiophile. Unmatched by units costing twice the price, the ST-11 is two distinct receivers in one featuring 4 uV. for 20 db quieting. Variable AFC. Single front panel switch controls AM, FM or STEREO selection.

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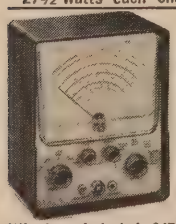
SPA-55 STEREO AMP 55 watts stereo-monaural. 27½ watts each channel. Wired $79.95 Kit **$64.95**



ARKAY VT-10 6-INCH MULTI-PURPOSE VACUUM TUBE VOLTMETER

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FREE! Stereo booklet and catalog. Write Dept. RE
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reasons I have just renewed my subscription to your fine magazine for another 3 years.

How about an article on sound projectors? JAMES L. STELZIG
St. Cloud, Minn.

SPEAKERS IN TRUCKS

Dear Editor:

I found the article "Hints on Installing Mobile Radio Equipment" by R. J. Hendrick (Dec., 1959, p. 58) very interesting and comprehensive.

An additional solution to the common speaker installation problem may be helpful to your readers. Practically all late model cars and trucks have speaker grilles built into the dashboard for standard 5 x 7 or 6 x 9 speakers. Since most fleet vehicles don't use broadcast receivers, this spot can be used for the mobile radio speaker. The speaker supplied is replaced with a 5 x 7 or 6 x 9 oval.

The slight additional expense will be more than repaid by the esthetic and acoustic improvement.

CHARLES E. COHN
Chicago, Ill.

DEFENDS PART-TIMERS

Dear Editor:

RADIO-ELECTRONICS seems to be becoming a crying towel for some of these so-called technicians who cannot compete with *honest* part-timers! A good service organization has nothing to fear from part-timers. If a part-timer does not do good work, he'll go the way of many others who have tried the same thing.

Has licensing helped the medical profession? Doctors still can't cure the common cold. But if a physician loses a patient, he still presents his bill . . . and a lawyer collects even if his client goes to jail!

Many part-timers repair sets that some bigger shop has worked on and failed to repair satisfactorily. Most part-timers at least guarantee their work, and back it up!

I am for licensing, if a test goes along with licensing. That way we can eliminate these cry-babies!

AL HART

ADMIRES TESLA

Dear Editor:

Some day I hope to visit you to see the bronze bust of the death mask of Nikola Tesla. I consider Tesla one of the greatest minds ever to come to earth. It is too bad more people do not revere this great man. We are all so indebted to him. MAC STURM
Philadelphia, Pa.

(Nikola Tesla, 1857–1943, inventor of the induction motor, was the holder of over 700 patents. His early experiments foreshadowed remote radio control, tuning and wireless transmission of power. More and more people are coming to recognize this lonely visionary genius as a true giant of radio, "possibly the greatest inventor who ever lived."—*Editor*) END

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unlimited versatility . . .
exceptional performance . . .
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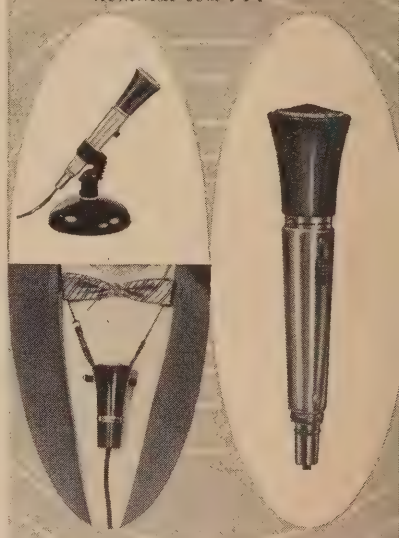

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the Commando is available in three models:

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A dual-impedance unit with A25 swivel adapter, on-off switch, cable connector
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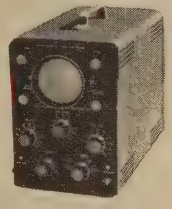
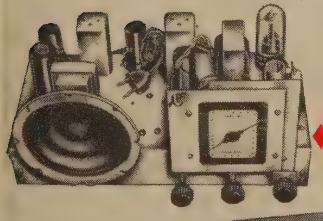
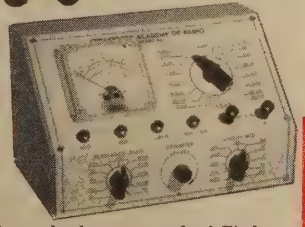




You build this powerful two-band superheterodyne radio receiver.



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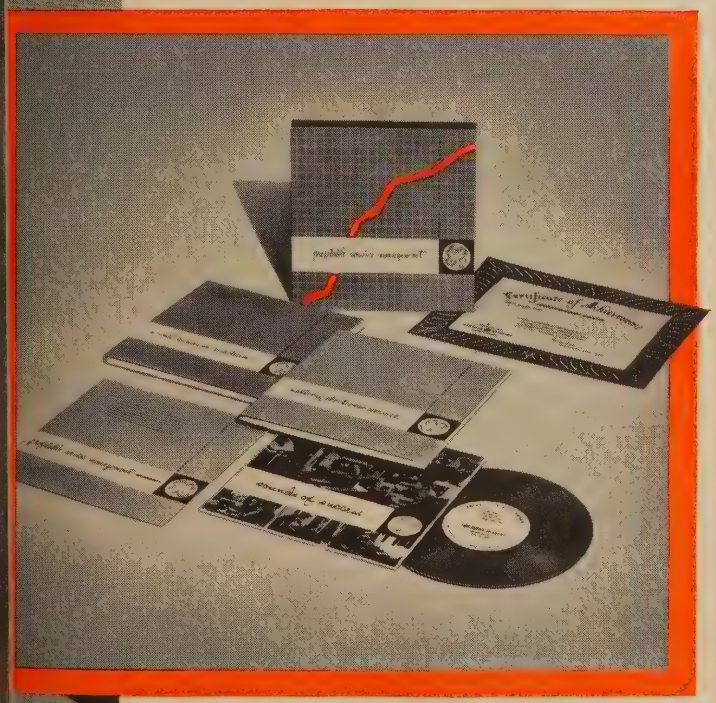
Earn the good things of life for yourself and your family by following the Profit signposts on every page of General Electric's PSM* Method! The engraved Certificate which says you have completed this instruction program, will mean new success for you as a TV technician.

Says Dr. John K. Pfahl of Ohio State University, under whose direction the new General Electric program was prepared: "The electronic service dealer must be, at the same time, a technician, good businessman, and sales manager." You learn step-by-step how to realize these aims, by following General Electric's Profitable Service Management Method. You are shown how to *assure* a satisfactory profit margin, not merely hope for it—how to increase business by methods others have found unfailingly effective.

In the LP record "Sounds of Success" you will hear from the lips of experienced TV technicians just how they have built greater incomes. After completing the two volumes of instruction that make up the study course, a questionnaire is available to check your acquired knowledge, prior to receiving your Certificate.

All come handsomely packaged for your bookshelf. Check the highlights of General Electric's PSM* Method given below! Then see your G-E tube distributor! *Distributor Sales, Electronic Components Division, General Electric Company, Owensboro, Kentucky.*



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ORGANIZING YOUR BUSINESS: Overhead costs...Pricing...What it costs you to make a service call...What it costs you to make a shop repair...Inventory control...Credit organization...Choosing a form of organization.

CONTROLLING YOUR BUSINESS: Why use records?... What records are needed...Taxation...Use an accountant.

BOOK NO. 2. "SELLING ELECTRONIC SERVICE"

ARE YOU ATTRACTING NEW CUSTOMERS?: Attracting new business...Businesslike appearance...Effective selling... Good identification...Basic market research.

PROMOTING YOUR BUSINESS: Advertising technique... Advertising campaign planning...Special offers...Seasonal planning...Customer contact.

KEEPING YOUR CUSTOMERS SATISFIED: Customer relations...Customer grievances...Guaranteeing repairs...Building new customers.

Progress Is Our Most Important Product

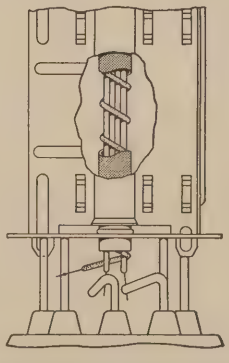
GENERAL ELECTRIC

311-401

No more fireworks for me!

(NO MORE DAMPER ARCING FOR YOU)

Typical of the many design features of CBS dampers is this new anchored heater-cathode insulator. Actually a tungsten coil coated with insulating material, it is mechanically anchored to prevent any movement that might lead to heater-cathode shorts. As a secondary precaution, the coil has fewer turns to minimize cathode-to-insulator contact, yet maintain perfect heater-cathode spacing.



"Damper diodes are prone to fireworks. Not me. I've been arc-proofed from heater to cathode to plate . . . and I'm blast-tested to insure it. That goes for my whole family of CBS damper tubes. Use us and relax."

It's true. CBS damper diodes have been completely redesigned to offer you *total reliability* . . . proved in performance by leading TV and radio set manufacturers. You, too, can profit more from the *total reliability* of CBS tubes. To prove it . . . just replace with CBS.

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A Division of Columbia Broadcasting System, Inc.

Here is the new Standard Coil Tuner Replacement and Repair Program that enables you to offer better service to your customers at greater profit. Now Standard Coil Products provides the tools that will enable you to cash in on the profitable tuner repair and replacement market.

TUNER REPLACEMENT LISTING IN SAMS PHOTOFACT

Starting in January, Standard Coil tuner replacement listings will appear in all Sams TV Photofact. Tuner replacement information will be right at your finger tips. Standard Coil is the *only* manufacturer ever to provide this service.

NEW TV TUNER REPLACEMENT GUIDE

Lists original equipment TV tuners with the Standard Coil equivalent replacement for each. Also includes major mechanical replacement parts for all Standard Coil Tuners —those used in original equipment as well as the universal replacement. Eliminates all guesswork—minimizes your tuner repair and replacement problems.

48 HOUR FACTORY GUARANTEED REPAIR SERVICE

Standard Coil's special service department set-up assures factory guaranteed repairs—*on a 48 hour in-plant cycle!* All repaired tuners carry a *six month warranty* on defective workmanship and parts failure (excluding tubes). Gives you more time for additional service calls—promptly returns your customer's set to like new operating condition.

DEFECTIVE TUNER TRADE-IN ALLOWANCE

Tuners which can *not* be repaired can be traded in against a new replacement tuner which carries a full *twelve month factory guarantee.* See your Standard Coil Distributor for complete details on how trade-ins can increase your tuner sales and profits—create greater customer satisfaction.

JUMP ON THE STANDARD COIL PROFIT WAGON TODAY!

For additional details, see your authorized Standard Coil Distributor or write to:

Standard

Coil Products Co., Inc.

2085 North Hawthorne Avenue, Melrose Park, Illinois

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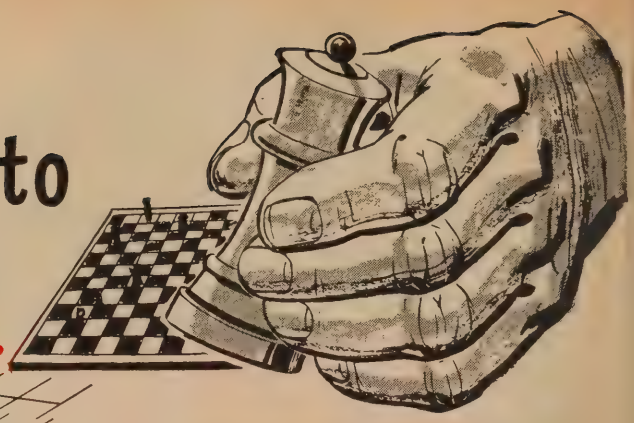

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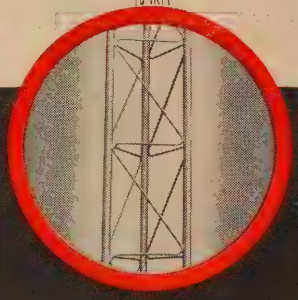

From every standpoint, ROHN Towers offer you MORE . . . more quality, more variety, more advanced design, more sales features, more service, more total sales and more PROFITS! Move forward with these ROHN items!

ROHN TV TOWERS

ROHN makes the finest towers available for television reception! Illustrated is the No. 25 with amazing "zig-zag" cross bracing design. The entire tower is rated 33% stronger than other similar sized towers. Yes, sell and install the No. 25 up to 50 feet self-supporting or, properly guyed, up to 360 feet!

Or if you prefer, sell the popular ROHN No. 6 tower with the famous "Magic Triangle" cross-bracing. Both are fully HOT DIPPED GALVANIZED AFTER FABRICATION! Sections in easy-to-handle 10 ft. lengths.

ROHN COMMUNICATION TOWERS

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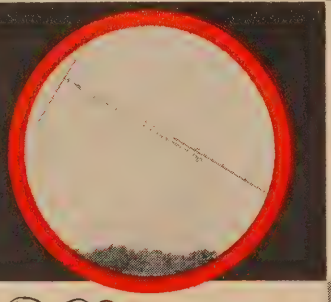

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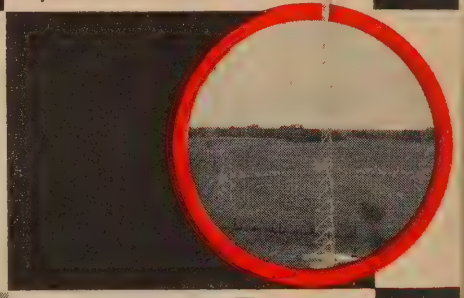

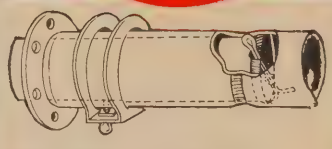

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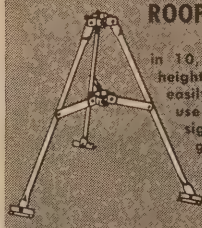

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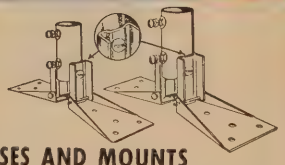

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New HFS3 3-Way Speaker System Semi-Kit complete with factory-built ¾" veneered plywood (4 sides) cabinet. Bellows-suspension, full-inch excursion 12" woofer (22 cps res.) 8" mid-range speaker with high internal damping cone for smooth response, 3½" cone tweeter. 2¼ cu. ft. ducted-port enclosure. System Q of ½ for smoothest frequency & best transient response. 32-14,000 cps clean, useful response. 16 ohms impedance. HWD: 26½", 13⅞", 14⅜". Unfinished birch **$72.50.** Walnut, mahogany or teak **$87.50.**

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††Shown in optional Furniture Wood Cabinet **WE70: Unfinished Birch, $8.95; Walnut or Mahogany, $12.50.**

C-3

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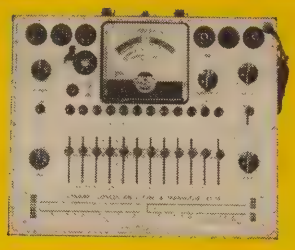

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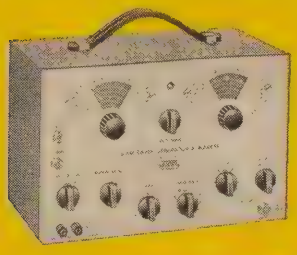

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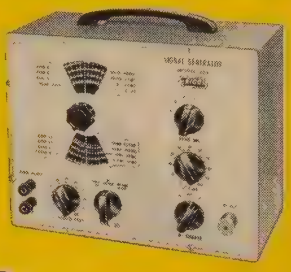

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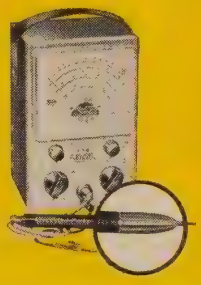

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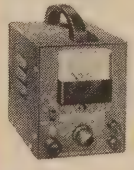

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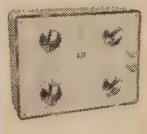

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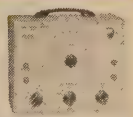

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BRAIN AN ELECTRIC COMPUTER

By DAVID STAFFORD-CLARK*

The following is part of an address delivered to the Annual General Meeting of the Mental Health Research Fund given in London early in 1959. In view of the great interest in electronic computers and their vast impact on our current thinking and research, we have arranged with Dr. Stafford-Clark, an eminent thinker in his field, to bring to our readers the latest thoughts on biological vs. electronic computers. —H.G.

IT is perhaps in the study of man's conscious and unconscious reaction with his environment in its widest sense that the method of psychological inquiry has still its greatest single contribution to make. Man has been called a communicating animal; and certainly he conveys and experiences his loves and hates, his hopes and fears, his values and principles, and the greatest discoveries of his mind, through a communications system which is the most complicated and yet most flexible known to exist. The mathematical theory of communications, which can be related to psychological methods of inquiry and concentrated in the dedicated study of man's mind by man himself, may provide ultimately one of the keys by which all our interlocking processes of human existence, and particularly of practical psychiatric knowledge, can be opened for our fuller understanding.

There is a good deal to be said for using the working analogy of an electronic computer to convey something of the way in which the brain works in this sense. But the brain is an electronic computer with fifteen thousand million separate cells, of possibly immeasurable complexity, which provides for its remarkable flexibility and wonderful precision. We have already seen that the electroencephalogram, crude though its information must yet remain, at least supports the view that it is in its electrical function that we must seek the practical key to the work of the brain. Its communication is by electrical signals, and their transmission from neurone to neurone through synapses is probably the way in which patterns of activity are regulated and controlled. It has indeed proved possible to use the mathematical theory of communications to draw some tentative conclusions about this aspect of the work of the brain (Ashby, 1952).

But all models which have so far been constructed to give working analogies of brain function have taken the source of their electrical power for granted. Such power has in fact been piped in from the local main supply in the laboratory, or stored in accumulators [batteries] hitched on to the working model. *I am sure that in all our research we must never forget that the brain is the only electronic computer which manufactures its own electricity biochemically as it goes along.* In studying the functions of the brain, therefore, we have to remember that we are at least two removes from the subjective experiences, and from the output in terms of behavior, which we seek to explain. At one remove there is the electrical network, in all its wonderful complexity and beautiful intricacy; and at the second remove there is the biochemical process, also wonderfully intricate and many-sided, whereby the brain continues to live, to breathe, to gain its nourishment and to make its power. It is in the biochemical aspects of brain function in health and illness that we see those changes which may affect both conductivity and availability of electrical power within the system. And it is the ultimate translation of this power into electrical signals, which are themselves the only measurable accompaniment to thought and feeling, which presumably alone makes these processes possible.

Our relative technical proficiency in measuring biochemical changes must never blind us to the fact that these are of ultimate importance only in their effect upon the patterns of electrical activity, conduction, communication and control in the final functioning of the brain; and as clinicians we must never forget that communication remains the ultimate key to the treatment of schizophrenia, or indeed of any other kind of illness. In one sense the cardinal features of schizophrenia may perhaps be regarded as respectively: (1) A failure to make the usual interpretation of external or internal events; for example, to understand what is going on in the world outside, or indeed what might be going on in one's own body. (2) A failure to communicate in the usual way with other people. (3) A failure to integrate interpretation and communication, within one's self or with others, in a way which will allow even the first two difficulties to become apparent in their full nature to any but the trained observer.

There is, in fact, so far as brain function is concerned, a failure of communication and control. Clinically it is this failure of communication and control which brings the schizophrenic to the doctor. However skilful and appropriate our physical treatment of schizophrenia may become as the result of refinement in our knowledge and understanding, both of the biochemical processes which may underlie it and the electrophysiological processes whose secondary disturbances ultimately bring about the illness. It remains true that we can treat patients successfully, and restore them to true health and happiness, only if we gain contact with them at a human and personal level, and give them thereby the bridge over which they may cross back to normal harmony and understanding with their fellows. This is the ultimate aim in every aspect of clinical research in psychiatry; and indeed it is the ultimate aim of all forms of research directed toward the understanding or relief of mental illness. END

*MD, FRCP, DPM. Physician-in-charge, Department of Psychological Medicine, and director of the York Clinic, Guy's Hospital, London; consultant physician, Bethlem Royal and Maudsley Hospitals, and Institute of Psychiatry, University of London

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A Raytheon RAY-12 radiotelephone in use.

By ELBERT ROBBERSON

TODAY any owner of a small boat can carry a two-way radiotelephone aboard. The equipment takes up little space, and the owner need not take a license test or even know the difference between a transistor and a quenched gap. And the recent development of outboard cruisers with electric starting motors, generators and 6- or 12-volt batteries means that marine radiotelephone activity should grow all over the country. Now is a good time to get acquainted.

The primary purpose of marine radiotelephony is to promote safety. Equipment is designed to be as simple and foolproof as possible, and to be compact in size as well as easy on the batteries. The standard frequency range is from 2 to 3 megacycles, and transmitter power runs from 15 to 150 watts. The transmitter and receiver must operate on a number of preset channels, with all critical controls behind the panel, available only to the service technician, who must have a commercial Second-Class or higher FCC license.

Operator controls are limited to the bare essentials. The simplest phones have only a receiver on–off switch and volume control, a channel-selector ganged-wafer switch that controls the operating frequency of both the transmitter and receiver, and a transmitter on–off switch. A push-to-talk button on the microphone or telephone handset, or a panel switch, disables the receiver, switches the antenna and puts the transmitter on the air for talk periods. More elaborate equipment has such extras as a receiver tuning control for the standard-broadcast band, automatic noise limiter and squelch controls, transmitting antenna tuning trimmer, and loudspeaker–handset switch for receiver audio output.

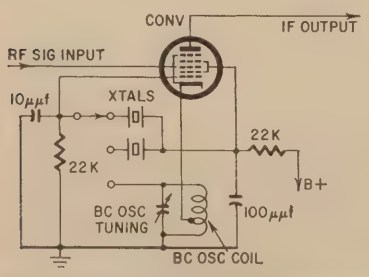


Fig. 1—Simplified Pierce oscillator used in radiotelephone receivers.

Receiver circuits

To keep battery current drain to a minimum, as few tubes as will provide the essential receiver functions are used. The superhet circuit is employed exclusively, with the oscillator frequency controlled by a quartz crystal for each communication channel. The mixer–input circuit usually is tuned by one inductor and separate trimmer capacitors for each channel, the channel being automatically selected by the channel switch. Sometimes, however, separate slug-tuned coils are used. A ganged variable capacitor and separate mixer input and self-excited oscillator coils are used to cover the broadcast band.

Many sets have an old familiar line-up of tubes—6K8 mixer; 6SK7 if amplifier; 6SQ7 second detector, avc and first audio, and a 6V6 audio power amplifier.

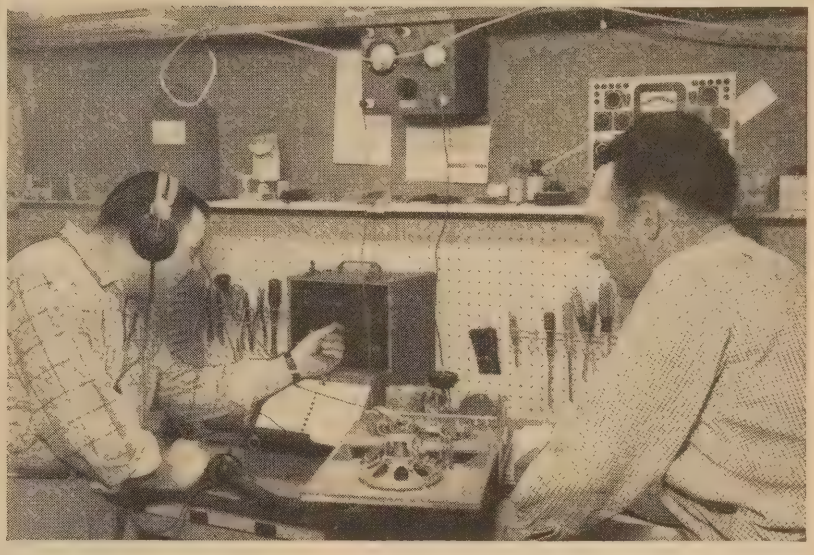
While larger phones may have more modern tubes, with an rf stage before the mixer and, perhaps, an additional if amplifier, automatic-noise-limiter diode and a squelch tube, there is nothing tricky about the circuits. One feature, however, which differs from any other simple multi-band receiver design is the crystal oscillator. The most common circuit is a form of Pierce oscillator—a simplified version is shown in Fig. 1, with the crystal effectively between the grid and plate of the oscillator section of the mixer tube, providing positive feedback at the crystal's resonant frequency. On the broadcast band, a coil and variable capacitor are switched in, resulting in a form of the familiar Hartley circuit. One of the several crystals for the different channels (ground to frequencies 455 kc removed from signal frequency) or the broadcast-band oscillator coil is selected by the channel switch for frequency changing.

Boat receivers are particularly sensitive to interference from the engine ignition system, since there is ordinarily no shielding around the engine and spark pulses are transmitted directly to the telephone antenna. To minimize this sharp-peaked noise, simple noise

Radiotelephones are available for the smallest boats. Here a Sonar portable is being hooked up.

Transmitting frequencies must be measured periodically.

Trivoli Radio & Marine



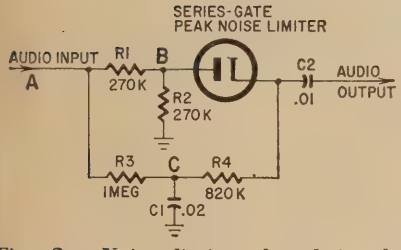


Fig. 2 — Noise limiter found in the Bendix model 42A radiotelephone.

limiters are common. Fig. 2 shows one such arrangement, used in the Bendix model 42A radiotelephone.

An unmodulated signal carrier establishes a negative dc potential at point A, which is divided across the two 270,000-ohm resistors (R1 and R2), which form the load for the second detector. Therefore, half of the detector's output voltage is impressed on the noise limiter's anode. The constants of the filter (R3, R4 and C1) are such that point C is held to the average level of signal. Normally, point B is positive with respect to point C, so the diode conducts, passing the signal. However, on receipt of a noise pulse, point B shoots sharply negative (while C remains at the average level), cutting off the diode and interrupting the audio circuit.

Because the receivers have avc, sensitivity jumps up to maximum between received signals, resulting in an annoying amount of noise. Accordingly, a squelch circuit is often used. Many variations are found, but the principle is illustrated by the Bendix 42A which employs the circuit shown in Fig. 3.

The between-signals noise level establishes a certain negative avc potential across the squelch control (R1) which is set so the squelch tube conducts. This pulls the grid of the af amplifier in the negative direction to cutoff. A signal causes the avc negative-voltage increase to cut off the squelch tube. When this happens, the grid of the audio amplifier swings toward positive, the tube conducts, and the signal goes on through.

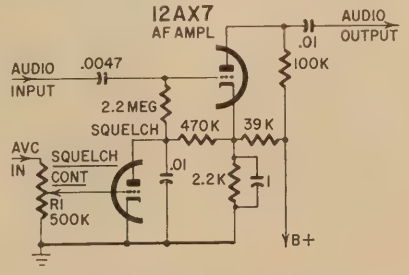


Fig. 3—This squelch circuit is used by Bendix in their model 42A.

Transmitter circuits

Because electrical power on a small boat is limited, transmitters are designed to get a signal on the air with the fewest number of tubes. The rf section, accordingly, consists of the minimum legal lineup: a crystal-controlled oscillator and one rf amplifier stage, operating straight through on the crystal's fundamental frequency. Two amplifier tubes are used in parallel when more than one tube's worth of power is needed.

For simplicity, the oscillator uses either some form of Pierce circuit or a modified Colpitts. Because neither circuit contains tuned elements, channel changing is just a matter of switching from one crystal to another. An example of the Colpitts-derived oscillator is used in the Kaar TR249, shown in Fig. 4. In this oscillator, the tube cathode is isolated above ground by rf choke RFC1, and positive feedback from the output to the grid circuit is provided by capacitors C1 and C2.

In the rf amplifier, extreme care is necessary to suppress harmonics, since many of the second harmonics, easily radiated by the short antennas used on boats, fall on critical aircraft frequencies. Therefore, grid drive and bias are carefully set and tuned-plate circuits are high-C to give maximum operating Q.

The FCC requirement that all fre-

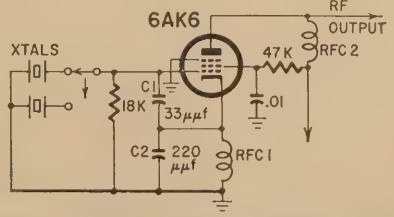
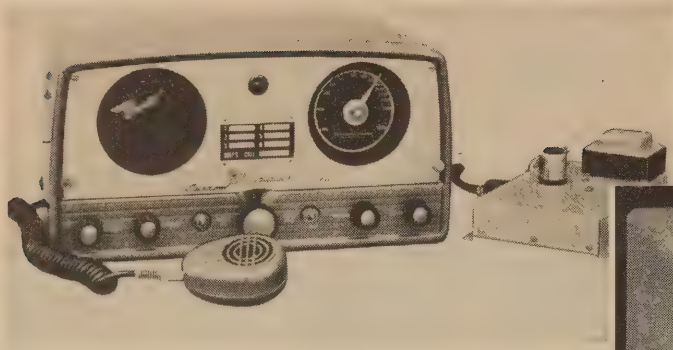


Fig. 4 — Colpitts-derived oscillator used in the Kaar TR249.



The Bendix 42A radiotelephone with its transister power supply.

quency-governing adjustments be preset by a licensed technician could be met in a number of ways. One, of course, would be to have separate tank tuning capacitors in the rf amplifier plate circuit, each pretuned to the desired frequency and selected by the channel switch. But this would add to the transmitter's bulk and cost. Since space and economic considerations are very important in this field, separate inductor taps for each channel are often used instead. Mechanically, this is done by using clip leads tapped onto the plate coil and brought to the channel switch. To keep plate voltage out of the tank coil, which, of course, must be handled during the tuning operation, parallel plate feed is the rule.

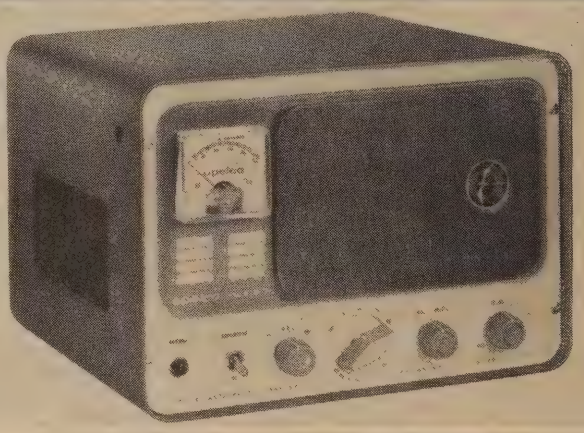
To attenuate harmonic output, Hudson American Corp. transmitters have a Faraday shield between the rf amplifier plate coil and the antenna coupling coil. However, most transmitters have pi-network—or low-pass filter—rf output. A representative circuit is shown in Fig. 5.

The tube is most commonly a 6L6 or 807, capacitively coupled to the oscillator. Rectified drive current develops grid-bias voltage across R1, which may be supplemented somewhat through the use of a bypassed cathode resistor. This latter feature also tends to limit off-resonance plate current to a safe value. A jack in the cathode circuit permits metering while the equipment is being tuned.

Voltage from the modulated B-plus source is supplied to the screen and is grounded for rf by C1, whose value is chosen to act as an rf ground without being high enough to soak up any serious amount of audio voltage. Careful layout (and sometimes parasitic suppressor resistors in plate, screen or grid circuit) keep the amplifier "cool," without need for neutralization.

Although a fixed value of plate tuning capacitance is shown (C3, Fig. 5), two or more additional capacitors are used when a wide spread of frequencies must be covered, to keep tank Q at the optimum value. Such capacitors are cut in on channels where they are required by another wafer on the channel switch. Small trimmers are also sometimes used at this point to fine-tune the tank, although this is not ordinarily essential, because of the broadening out of amplifier tuning

Hudson-American's Nautilus 1 has a 135-watt output.



APELCO AE-75M has a plate current meter on the panel.

RCA makes this 20-watt radiotelephone. It is their ET-8059 Golden Sentry. The booster control is the transmitter's antenna tuning trimmer.

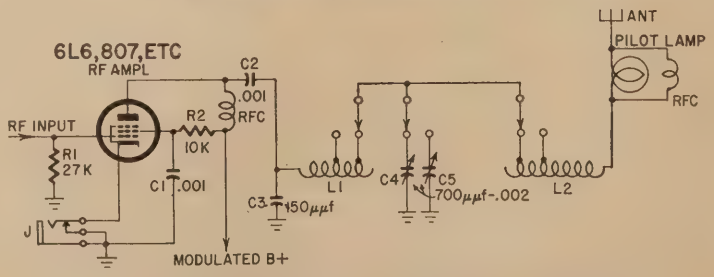


Fig. 5—Low-pass filter between rf amplifier output and antenna attenuates harmonic output of transmitter.

when the antenna load resistance is coupled in. The main plate tuning is accomplished by fastening the taps to the proper turns on the coil.

Coupling to the antenna is provided by C4, C5 and additional capacitors in broad-frequency-range transmitters. Ordinarily, two values are enough for covering the two sets of normal marine-band frequencies—one around 2.1 mc and the other around 2.6. Jumpers on the channel switch connect in the capacitor required for the family of frequencies in use.

On all except the largest vessels (such as lofty-masted sailboats), the antenna is very much less than one-quarter wavelength long, so it must be loaded inductively. The antenna is tuned with clip leads, and relative output is indicated by a pilot lamp shunted by a very small coil to prevent filament burnout or introducing lamp resistance directly into the antenna circuit.

Some telephones also incorporate a variable inductor (not shown on the diagram) in series with the antenna loading circuit so the operator can touch up antenna tuning when necessary to compensate for unpredictable detuning caused by movement of the boat's rigging, etc.

Modulators

Some very small radiotelephones use the receiver's af power amplifier as a transmitter modulator. Usual practice is, however, to have a separate modulator. The simplest arrangement, and one which has been very popular, is shown in Fig. 6. Because the carbon microphone has a high gain, no speech amplifier is necessary, the modulator-tube grid being driven directly by the microphone transformer. Microphone current is obtained from the tube cathode, although it is sometimes taken from the B-plus line through a resistor. The FCC requirement that bandwidth be limited to frequencies required for the transmission of speech is met by using a microphone of limited bandpass, with rapid cutoff above 3,000 cycles. Overmodulation is prevented by limiting average modulation levels to about 75%.

A sensitive carbon microphone is used directly in some equipment to drive a pair of modulators as large as 807's. In others, a speech amplifier stage is used, with the carbon microphone in the cathode circuit.

An example of the latest practice employs a crystal microphone with a resistance-coupled speech amplifier the output of which is fed through a 12AX7 speech clipper and an audio filter into a pair of paralleled 6L6's in a single-ended modulator. Usual practice, however, is to use push-pull when more than one modulator tube is required to produce the necessary audio power. Diode peak-limiting circuits are also used to eliminate overmodulating the transmitter.

Power supplies

Tube heaters are energized in series, parallel and series-parallel arrangements directly from the boat's battery of 6, 12 or 32 volts. Plate power is supplied by dynamotors, vibrator power supplies or most recently, by transistor power supplies. Designs are the same as are common in other mobile equipment. Small units have only one plate power supply. Its output is transferred from receiver to transmitter and vice versa as required. This would be uneconomical in the larger units, so they use a small power supply for the receiver and control circuits, with a high-voltage dynamotor for transmitter power.

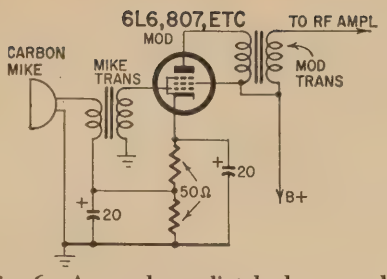


Fig. 6—A popular radiotelephone modulator circuit.

A few units are built to operate from 117 volts ac, supplied either by an engine-driven alternator or a converter fed from the boat's dc lines. These are used rarely, and only on the largest craft.

Installation and maintenance

In a boat, a solid and well-thought-out installation is essential. Equipment should be placed where it will be convenient to operate, but also with consideration to short antenna and ground leads, as well as power input lines. Because there isn't much voltage to begin with on a small boat, extra-heavy wiring is standard to minimize voltage drop, especially for transmitting when comparatively heavy current is being drawn.

Radiotelephone equipment should be connected to the battery, switchboard or accessory power outlet by cables which are not used for another load. The lines should be fused at the power end, but in the hot lead only. A fuse or circuit breaker should never be installed in the ground lead of a power feeder.

Manufactured antennas available from radiotelephone manufacturers are used on most powerboats. They are supplied with hardware for mounting alongside a cabin or on deck. The main thing is to provide enough mechanical strength in the supporting members to withstand the strain when the boat is rolling or pitching violently. A great many carelessly installed antennas have either broken or pitched overboard through lack of care in installation. Another important point is to be extra careful of the insulation in mounting and lead-in insulators—a small amount of leakage caused by a film of salt spray on an inadequate insulator can seriously affect transmitter range.

On sailboats, a wire is secured to the mast or hung from a point aloft, or a span of the boat's standing rigging, such as a backstay or a shroud, is isolated by splicing in insulators. The important thing is to choose a location for the antenna wire where it will be as much in the clear as possible.

A radiotelephone will perform, after a fashion, with the boat's engine as a ground. However, for maximum transmitting range, the ground-connection area should be as great as the construction of the boat will allow. A ground consisting of a sheet of copper with an area of not less than 12 square feet is considered the minimum for satisfactory service. Such ground plates are screw-fastened to a flat area on the bottom of the hull or keel and connection made by a bolt through the hull. Plates are sometimes installed inside the bottom of small high-speed boats. In this case, there is no direct connection to the ground, the capacitance of the plate to ground serving instead.

Small-boat radiotelephones develop trouble more from inactivity or misuse than from wearing out. The main factors in routine maintenance are to make sure that the equipment is kept clean and dry, relay and switch contacts are bright and components such as vibrators and tubes are up to par. A large part of the service technician's difficulties arise from "operator trouble,"—the layman owner either does not work the buttons in the right manner or he does not understand some special circumstance that arises. In this category are such "defects" as strong static common in summer thundersqualls; excessive interference from other stations on a channel, common over weekends and holidays during the boating season, or just plain, ordinary being out of transmitting range for the amount of power on board.

So one of the important parts of installing and maintaining this gear is that of making sure the owner understands the limitations of the equipment, as well as how to operate his gear.

Receiver servicing is just the same as in any equipment you find ashore. And, with their simplicity, the transmitters seldom present any problems that cannot be solved with a visual rf probe—an ordinary neon bulb, that is.

Become acquainted with their little peculiarities, and marine radiotelephones offer an interesting field in which to work. END

VAIN HOPE

By Phyllis Barlow

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All will agree
My service is strictly
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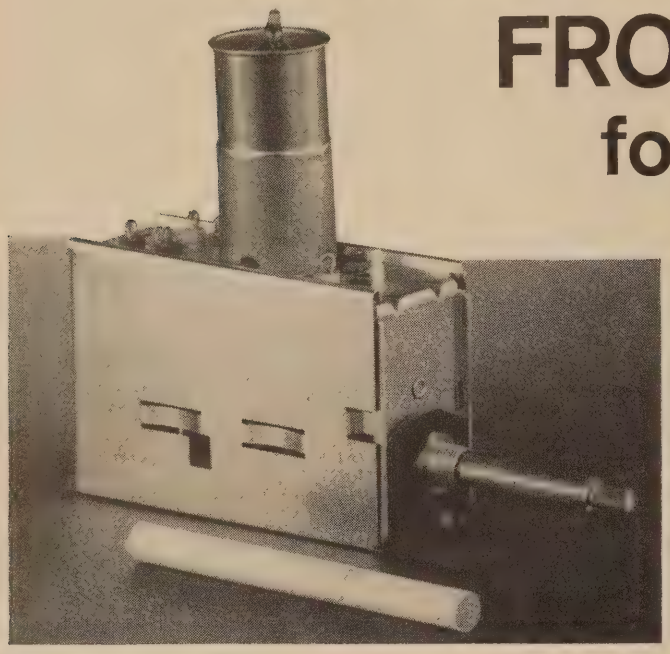
MINIATURE FRONT END for FM RECEIVERS



By following TV tuner techniques, the manufacturer has come up with an FM tuner that measures only 4¼ x 1¼ x 3¼ inches—including the tube

By E. D. LUCAS, JR.

A MINIATURE FM tuner—rf amplifier and mixer-oscillator—that employs only one tube is now being supplied by Standard Coil Products to some eight manufacturers of hi-fi receivers. A modified version may be made available to auto radio manufacturers in the near future. The tiny unit, which takes up less than 15 cubic inches, depends on a printed-circuit board to keep its size down.

As shown in Fig. 1, the input from the antenna is fed through feedthrough capacitor C16 and a bandpass filter (C15, L7, L8) to the cathode of a grounded grid amplifier (triode section of a 6AQ8 or a 6DT8). The second stage, the other triode section of the tube, is an autodyne oscillator–mixer that has controlled regeneration.

The unit is tuned by varying the inductances of L1 and L2 with brass slugs on a lead screw. The lead screw is coupled to the main tuning shaft with a sliding coupling. The slugs in L1 and L2 are individually adjusted at the factory so the frequency of the tuned circuits is correctly set for the high end of the FM band. L10 and L9 are shorted loops that enable the manufacturer to adjust the low end of the band. Tickler coil L4 is 1½ turns wound around L2, and linked to it by mutual inductance. It is adjusted for enough feedback to start the oscillator.

To improve the tuner's gain, an additional regenerative circuit provides if

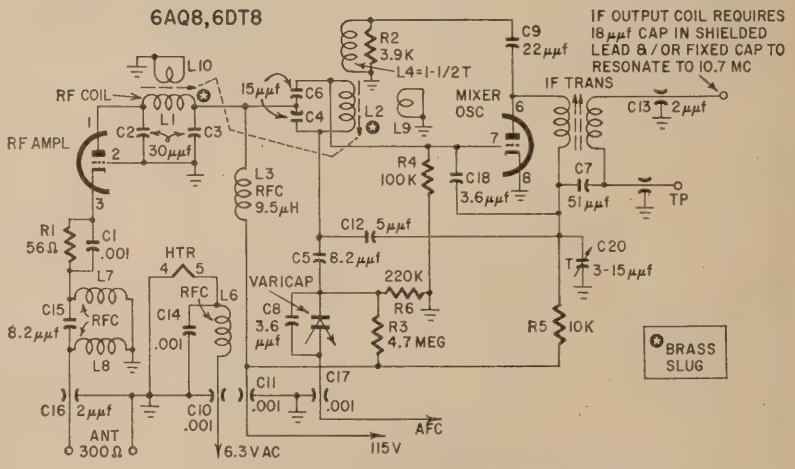


Fig. 1—Circuit of the single-tube FM front end.

feedback through C18 and C12 to the tuned tank circuit of the grid. Trimmer C20 adjusts the amount of regeneration, making it possible to compensate for variations in components. Without C20, capacitors and resistors would have to have tighter tolerances, which would increase the tuner's cost.

Another interesting design point (Fig. 2) is that the oscillator tank circuit contains a capacitor bridge, with C4 and C6 "split" to furnish a cold point—effectively zero for oscillator voltage — at their junction. The other arms of this bridge contain the grid capacitance of the oscillator and a composite afc capacitance consisting of the combined capacitances of C5, C12, C8 and the Varicap.

One reason the capacitor bridge is designed with such a cold point is to keep oscillator radiation to a minimum. Another is that by maintaining this point at zero for oscillator voltage, it is possible to connect the associated rf amplifier circuit without changing the oscillator frequency. The cold point eliminates interference between the rf and oscillator tuned circuits. Should a measurable amount of oscillator voltage ever appear at this cold point, it would flow through the rf circuit. Since this circuit is tuned to a different frequency, such a flow would tend to pull

the oscillator, resulting in mistracking.

Automatic frequency control (afc) is accomplished by a change in the capacitive reactance of a Varicap. It is so selected that a variation in back bias will vary its capacitive reactance. Thanks to this characteristic, an error signal indicating off-frequency operation can be fed back from the FM receiver's discriminator or ratio detector for automatic oscillator-frequency correction. Capacitors C5, C12 and C8 are interdependent from both an if feedback standpoint (as previously described in connection with the capacitor bridge) and from the standpoint of afc sensitivity. The design in Fig. 1 will provide an oscillator frequency variation of 100 kc per volt applied to the afc terminal. Without regard to the interdependence just noted, a reduction in C8's value or an increase in C5's value or both will increase afc sensitivity. If such a modification is made, the autodyne circuit must be rebalanced, both as regards the cold point and the if feedback.

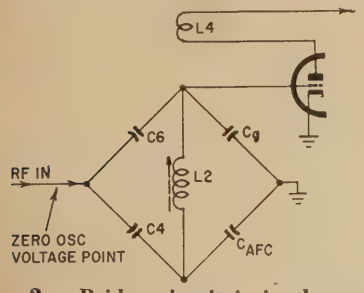


Fig. 2 — Bridge circuit is in the oscillator grid.

The voltage divider formed by R5, R3, and R6 provides the necessary positive voltage to back-bias the Varicap so the afc voltage can swing positively as well as negatively without causing current to flow in the Varicap.

The tuner's output is conventional through a double-tuned if transformer whose secondary feeds directly into the grid of the first if amplifier. The tuner output transformer's secondary requires approximately 18 $\mu\mu$f of capacitance in the shielded lead to the first if stage, or sufficient additional capacitance in the form of a fixed capacitor to bring the total value up to about 18 $\mu\mu$f, so the circuit will resonate at 10.7 mc.

Standard Coil is manufacturing two principal versions of this tuner, differing only mechanically, in the shaft arrangement. One version, used in receivers having a slide rule type of dial, has no gear-reduction unit connected to the tuning shaft, and 5½ complete rotations of this shaft are required for tuning over the full FM band. The other version has a gear-reduction unit which drives an outer shaft coaxial with the tuning shaft. This outer shaft can be used to drive a pointer directly. This pointer, normally used with a circular dial, will indicate complete coverage of the FM band through an arc of 254°. END

FM SENSITIVITY SWITCHES

Two sensitivity circuits in modern FM tuners

IN the early days of radio, before the advent of variable-mu tubes, many sets had local–distant switches to control a set's gain or signal input. After being practically extinct for a great many years, these sensitivity controls are beginning to show up again—particularly in high-quality FM tuners.

Fig. 1 is the front-end and agc circuit in the Scott 310-C FM tuner. The FM if signal is tapped off the grid of the first limiter and rectified to produce an agc voltage across load resistor R20. This voltage is filtered and fed to the grid of the input section of the cascode rf amplifier. When the NORMAL–DISTANT switch is in the DISTANT position, the bias on the rf amplifier is reduced and it operates at maximum gain.

It is not desirable to operate the cascode at maximum gain at all times because its linearity is not as good as when operating with a somewhat higher bias. The less linear an amplifier, the more sensitive it is to overloading. Its response to spurious signals also increases. The NORMAL position of the switch applies optimum agc bias to the tube, increasing its linearity and ability to handle high signal levels with minimum distortion.

Fig. 2 shows the rf amplifier and SENSITIVITY switch in the Sherwood S-3000 FM tuner. When the switch is thrown to LOCAL, B-plus voltage is removed from the first half of the cascode amplifier. Strong local signals are fed —without amplification—to the grid of the second half of the cascode through the inter-electrode capacitance of the input section of the stage. Switching to DISTANT places B-plus voltage on the input section so the cascode operates with its normal gain determined by the agc voltage applied to the grid of the input section. END

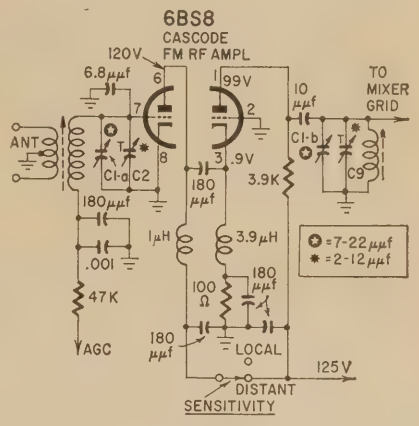


Fig. 2—The Sherwood S-3000 uses this circuit.

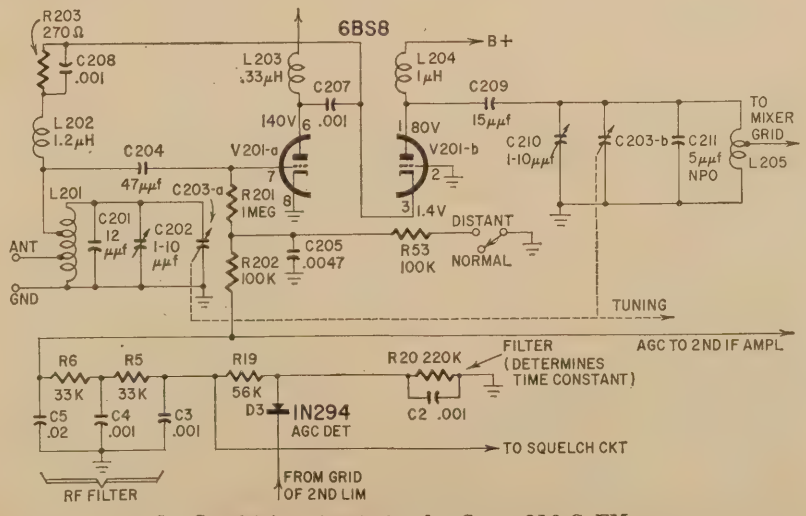
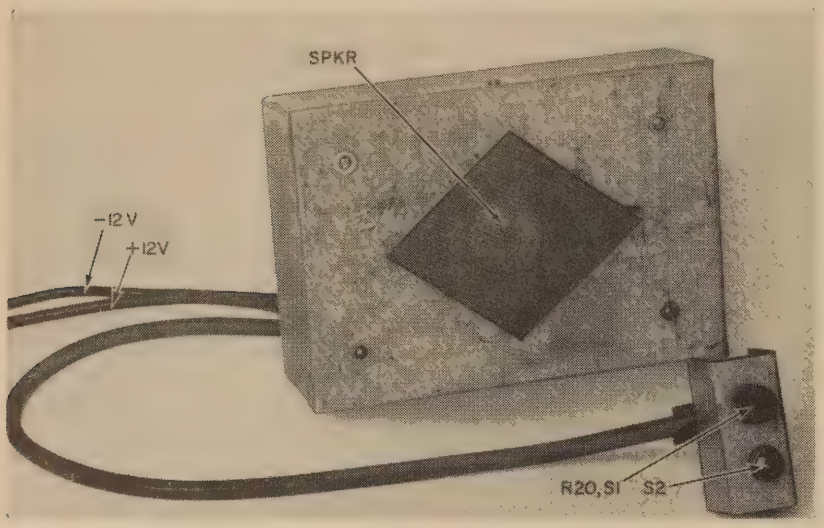


Fig. 1—Sensitivity circuit in the Scott 310-C FM tuner.

BUILD THIS TRANSISTOR AUTO RADIO

...it has signal seeker



Search-and-tune receiver is controlled by one knob and one pushbutton on the car's dash. The rest of the set is tucked into some out-of-the-way spot

By A. V. J. MARTIN

I HAVE a gripe with a sports car. Said gripe is the radio or rather the lack of one. Now adding a radio to a car is a rather simple matter, but I have some qualifications:

- I don't like conspicuous dials and knobs on the dash.
- I am partial to transistor equipment.
- I strongly favor automatic tuning.
- I am hopelessly limited in the amount of green stuff.
- I am too individualistic to be satisfied with a radio that is like everybody else's.

As a result, I had to build a radio to my own specifications. It is all-transistor and not limited to 0.25-watt output; I want to hear it when I have the top down. Also, it has to be heard, but not seen; I mounted it behind the dash, well out of the way. It has automatic tuning and a minimum of controls; in the final design there is only a search pushbutton and a combination volume control and on–off switch. Both are miniature types and quite unobstructive. They can be mounted on the dash or on a small angle bracket bolted under the dash.

My final design uses eight transistors and delivers several watts output. It has good sensitivity, automatic tuning and fits into a 8 x 5½ x 3-inch box.

Receiver circuit

Since the standard auto whip antenna is comparatively short and not very sensitive, the receiver (Fig. 1) has an rf amplifier, using a 2N140, to increase sensitivity. The rf stage's input is untuned and its output feeds the rf tuned circuit through a tap on L1. The coil we used had no secondary, so we made one by winding six turns of wire around the existing winding. Small-gauge hookup wire was used, but most wire will work just as well.

The mixer, another 2N140, also works as an oscillator through emitter-to-collector coupling. The collector side of this coupling is connected in series with the first if transformer's primary. In the two if stages 2N140's are used. No neutralization was needed.

The last if amplifier drives a 1N295 crystal detector providing the audio signal and the avc voltage. The avc output is filtered and applied directly to the base of the first if amplifier. At the same time, the emitter voltage of this controlled transistor follows the variations of the avc signal and is used as the avc voltage for the mixer and the second if amplifier with suitable decoupling. The collector supply to the first if amplifier also contains a decoupling circuit for stability.

The audio signal appears across the 5,000-ohm volume control. The af signal is applied through an R-C coupling to the first audio amplifier, a 2N109.

A transformer-coupled driver feeds the 2N301 power amplifier. The recommended operating point for this transistor is at 400-ma collector current. But, with limited space, it is impossible to use a heat sink large enough to cool the transistor efficiently. The solution was a temperature-sensitive resistance —in its inexpensive version—two bulbs from a Weller soldering gun (2.2 volts, 250 ma each). They are connected in series between the power transistor's emitter and ground. With the values given for the voltage divider in the base circuit, these two bulbs just glow. If they do not, reduce the value of the resistance between the base and the —12-volt line.

At this point the resistance of the bulbs increases rapidly with current, and the output stage is stabilized and shows no tendency to run away. This corresponds to approximately 300-ma collector current.

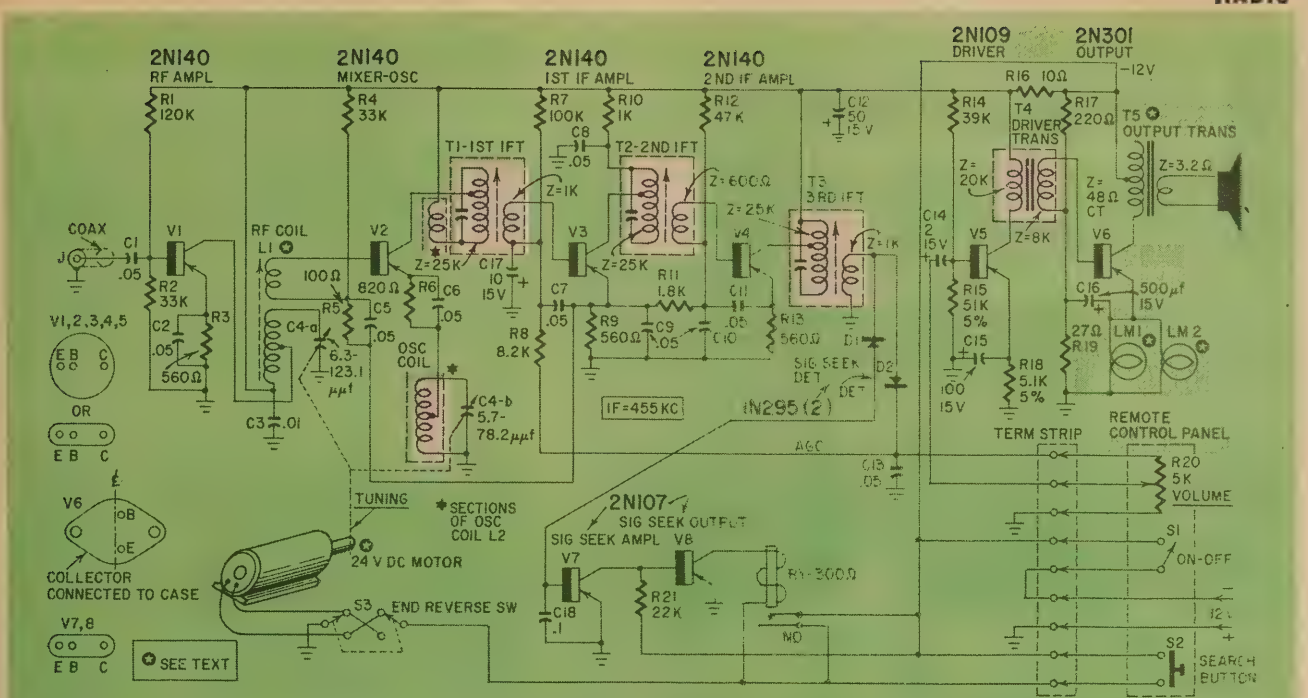
A 6-watt output transformer is used in the receiver. For best matching, only half of its center-tapped primary is used.

AST signal-seeking system

The Automatic Search and Tune system in the receiver is the result of a lot of experimenting and head scratching. The heart of the system is a surplus motor measuring 3 inches in length and 1¼ inches in diameter. Its label

BENCH TESTED

A member of the staff of RADIO-ELECTRONICS checked the unit. He reports: "Ideal for the modern car. Unit plays immediately and works well. Search and tune circuit works effectively. Sound reproduction not as good as that of a standard auto radio, but to some extent may be due to the built-in speaker. Unit is especially good for small sports cars and many of the imported models. In these models, the radio can be mounted under the hood, the speaker under the dash, and the controls—volume and pushbutton tuning—on the dash.



R1—120,000 ohms
R2, 4—33,000 ohms
R3, 9, 13—560 ohms
R5—100 ohms
R6—820 ohms
R7—100,000 ohms
R8—8,200 ohms
R10—1,000 ohms
R11—1,800 ohms
R12—47,000 ohms
R14—39,000 ohms
R15—51,000 ohms, 5%
R16—10 ohms
R17—220 ohms
R18—5,100 ohms, 5%
R19—27 ohms
R20—pot, 5,000 ohms, with spst switch
R21—22,000 ohms
All resistors ½-watt 10% unless noted
C1, 2, 5, 6, 7, 8, 9, 10, 11, 13—.05 μf
C3—.01 μf
C4—miniature variable capacitor: rf section, 6.3–123.1 μμf; oscillator section, 5.7–78.2 μμf (Lafayette MS-261 or equivalent)
C12—50 μf, 15 volts, miniature electrolytic
C14—2 μf, 15 volts, miniature electrolytic
C15—100 μf, 15 volts, miniature electrolytic
C16—500 μf, 15 volts, miniature electrolytic
C17—10 μf, 15 volts, miniature electrolytic
C18—.1 μf
All capacitors 15 volts or higher
D1, 2—1N295
J—coax connector
L1—rf coil with added turns (see text) (Meissner 14-9015 or equivalent)
L2—osc coil (Lafayette MS-342 or equivalent)
LM1, 2—see text
Motor—see text
RY—300-ohm coil, drop out at 2 ma, pull in at 15 ma (Clare A-16280 or equivalent)
S1—spst on R20
S2—spst pushbutton, normally open, momentary contact
S3—dpdt toggle
T1, 3—if transformer: primary, 25,000 ohms ct; secondary, 1,000 ohms (Lafayette MS-269 or equivalent)
T2—if transformer: primary, 25,000 ohms ct; secondary 600 ohms (Lafayette MS-268 or equivalent)
T4—driver transformer: primary, 20,000 ohms; secondary, 8,000 ohms (Argonne AR-130 or equivalent)
T5—output transformer: primary, 48 ohms ct (only half of primary used); secondary, 3.2 ohms; 6 watts (Argonne AR-503 or equivalent)
V1, 2, 3, 4—2N140
V5—2N109
V6—2N301
V7, 8—2N107
Sockets, transistor (7)
Speaker, 3.2 ohm
Heat sink for V6, 2 x 2-inch aluminum sheet
Case, to suit
Angle bracket for R20 and S2
Miscellaneous hardware

Fig. 1—Circuit of the 8-transistor receiver.

says *"Delco Appliance, 145 rpm, 24 volts dc."* The motor includes a reduction gear and is available in surplus houses. If you buy it there, get the gear wheel it drives at the same time. Other motors with about the same specifications can be obtained from C&H Sales Co., 2176 E. Colorado St., Pasadena 8, Calif.

The motor runs in both directions on 12 volts dc by reversing the polarity. Enlarge the center hole of the driven gear wheel to fit the variable-capacitor shaft. The threaded holes in the gear wheel are used to attach two angle pieces which flip the reverse direction switch. Once you get them adjusted properly, solder the angle pieces to the gear wheel. This way, the motor drives the variable capacitor in one direction until it reaches the end of its allowable rotation. At this point, one angle piece flips the reverse switch over and the capacitor is rotated in the other direction, and so on (Fig. 2).

The electronic part of the AST system stops the motor when a station tunes in. To do so, the if signal developed across the last if tuned circuit drives a separate 1N295 detector. The detected dc voltage controls a two-transistor dc amplifier. If the received signal is strong enough, the stop relay in the collector circuit opens and cuts off the AST circuit and the motor. The circuit is designed so that total fading of a station (when going through a tunnel) will not actuate the system. Tuning will not change until the search button is pressed. This starts the motor running, detunes the receiver and cancels the voltage holding the second AST transistor cut off so the relay is excited and stays closed until a station is received that is powerful enough to open the relay again.

Note that in this design the output AST transistor draws current only during the short search period—a maximum of 4 seconds for end-to-end rotation.

An AST sensitivity control could be

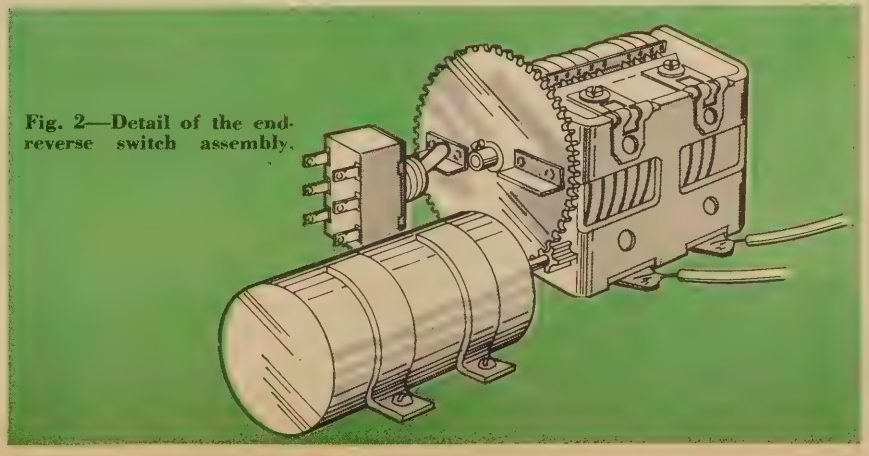
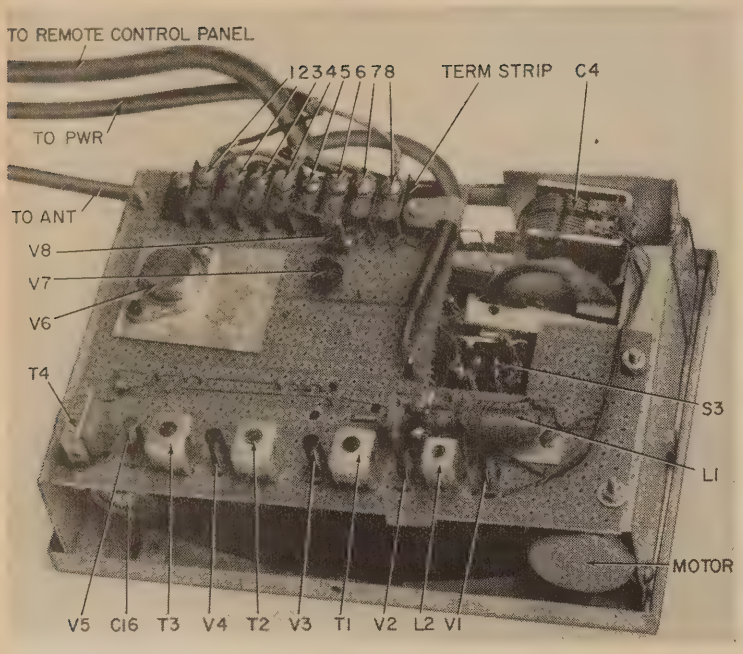
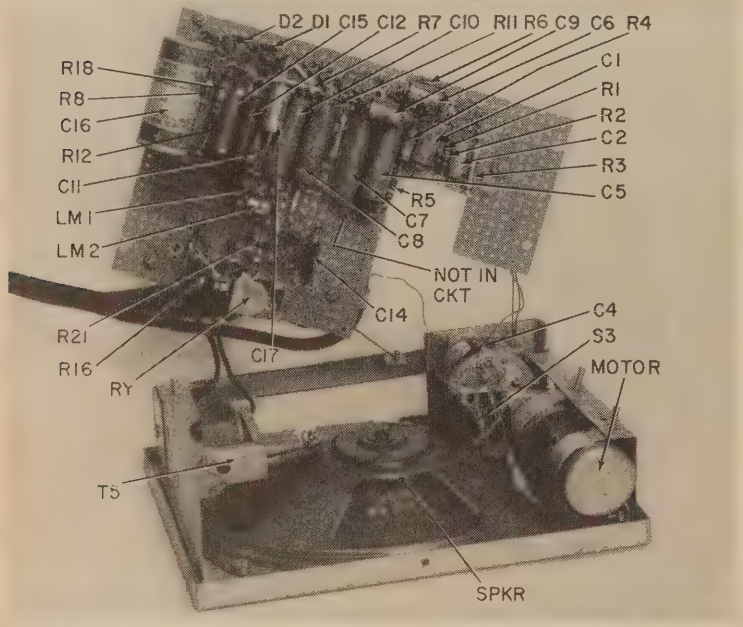


Fig. 2—Detail of the end-reverse switch assembly.



Top view of the auto radio's chassis. Note cut-out section of chassis board to make room for the end-reverse switch and tuning capacitor.



With the chassis lifted clear. Parts layout on its underside is revealed as is the motor and its mounts.

added (switching or varying a base to ground resistance in the AST input). I felt it unnecessary along with a silencing circuit to keep the receiver cut off while searching. The AST circuit delivers 18-ma no-station current and 1- or 2-ma on-station current. Any relay operating between these values will work. I used the one specified in the parts list, a Clare A-16280 available from Relay Sales Inc., Box 186, West Chicago, Ill., or Clare distributors.

Assembly and alignment

I used an elliptical 5 x 7-inch Audax speaker because it has an inverted magnet—the magnet is mounted in front of the cone—making the speaking thinner. Of course, standard speakers can also be used, just use a larger case. The photos show the way I arranged the parts. Note that the phenolic chassis is cut away to make room for the variable capacitor and the reverse switch.

A seven-conductor cable runs from the set to the control panel—two leads to the search switch, two leads to the on–off switch, and three leads to the volume control. Two other leads connect the receiver to the car's battery circuit. Heavy wiring is not needed as total power consumption is only about 350 ma. You might fuse the positive supply line with a ¾- or 1-amp fuse.

Alignment is straightforward. First set up the if circuits for 455 kc. Then, with the variable capacitor fully closed, adjust the oscillator coil slug to receive 550 kc, and tune the antenna coil slug for maximum sensitivity. Next, with the tuning capacitor fully open, adjust the oscillator trimmer for 1,550 kc and peak sensitivity with the antenna trimmer. Then start at the beginning and repeat all steps. Twice around is usually enough.

There are no other adjustments. However, you may have to suppress parasitic noise caused by your car. Resistor type spark plugs and capacitors across the generator and other motors—fans, blowers, etc., should do. Use a standard antenna and connecting cable.

Afc system

As designed, the set does not stop exactly on tune, but actually at the point where the detected dc voltage opens the stop relay. This tuning, though not exact, is good enough for practical purposes thanks to the receiver's high selectivity and energetic avc system.

From a purely technical point of view this isn't right. So I designed an afc circuit, using two crystal diodes and a voltage-sensitive diode to shift the oscillator frequency. While the system works better, it has not been included since no suitable if transformer is available. For those who want to make their own, the circuit is shown in Fig. 3. It replaces the last if transformer and detector of Fig. 1.

With the nominal 12-volt supply, current consumption is 350 ma. If the supply voltage goes up to 16, current drain goes up to 500 ma and operation is still satisfactory. If supply voltage goes down, power output decreases, but the receiver operates down to 5 volts, when total current is 100 ma.

CAUTION: Be sure to connect the power supply with the right polarity. The set shown is designed for use with a positive ground. To use with a negative ground system connections must be modified and the tuning capacitor insulated from the chassis. END

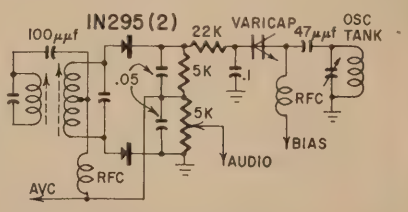
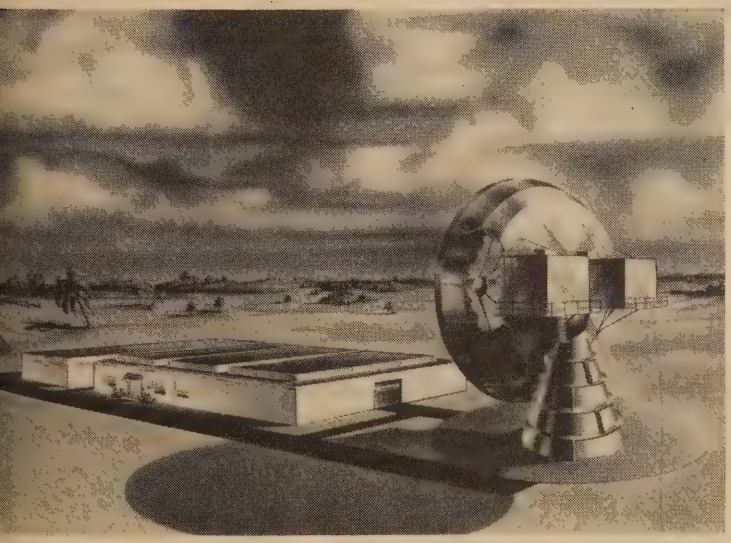


Fig. 3—Optional afc system will make station tuning exact.

what's new?

WORLD'S LARGEST RADIO TELESCOPE under construction near Sugar Grove, W. Va. The facility will be known as Naval Radio Research Station. Covering 7 acres, the mechanism will rotate and elevate a 600-foot-diameter aluminum-mesh reflector dish, which will probe into space for a distance 19 times the range of the 200-inch telescope at Mt. Palomar. A baby 60-foot dish remotely located will probe for interference sources. Scheduled for 1960 completion.

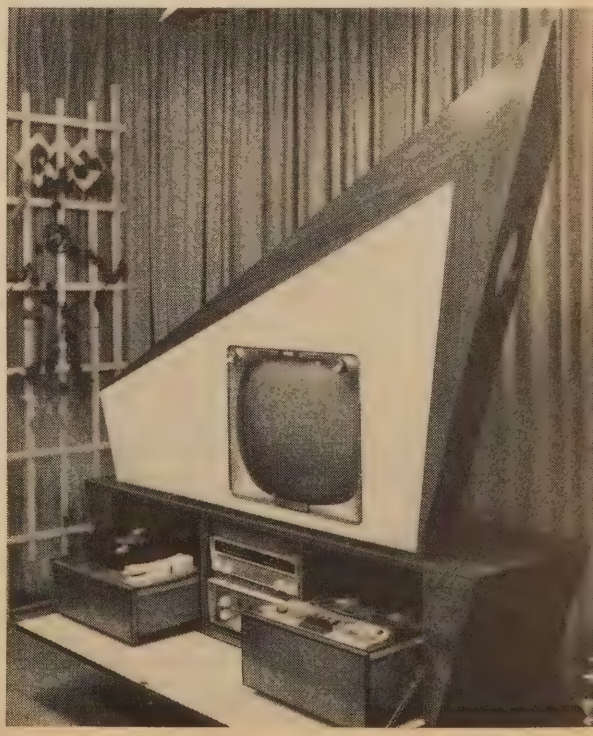


MISSILE DEFENSE of the future will include five-story-high Pincushion radar tracking antenna. System will use 12 or more narrow beams to fix on, follow and identify intercontinental ballistic missiles thousands of miles away. Important part of this radar will be super-power Amplitron tube (RADIO-ELECTRONICS, page 6, July, 1959; page 54, August, 1959). The 80-ton antenna is part of development by Raytheon for the Advanced Research Projects Agency.

UPI

ELECTRONIC LIFEGUARD works under water, sounds alarm if a child or pet falls into or enters unattended swimming pool. Submerged microphone picks up vibrations, sends them to remotely located relay control amplifier. Minneapolis-Honeywell.

MODERN-DESIGN entertainment center, *Fantasia*, has upswept wing, swiveling TV–stereo speaker section atop stereo disc, tape, radio, amplifier section. Front door (open here) closes when not in use. Arkay International.



COVER FEATURE

TURNTABLES and PICKUP ARMS built from KITS

Ten kits are on the market. All go together quickly and easily

By CHARLES B. GRAHAM
ASSOCIATE EDITOR

Audax KT-16 arm kit before assembly.

IN the past few years, while high fidelity has grown from a basement experimenter's art to its present state, another even bigger movement has been growing—do-it-yourselfism. As it has grown, it has overlapped into the high-fidelity movement. Merging of the two has created a demand for a large number of kits for putting together various parts of a high-fidelity music system.

A few years ago there were kits only for audio amplifiers. Then came kits for other electronic components—FM tuners, AM tuners, and combination FM–AM units. Kits for assembling loudspeaker enclosures were a natural development. And now we have kits for the other electromechanical parts of the playback system—tape recorders (two), record changer (one) and pickup arms and turntables.

The last are particularly to be recommended to the person just starting out who may be afraid of soldering wires and small parts. Arms and turntables are almost as easy to assemble as speaker kits, and can provide an excellent introduction to kit building for the man or boy who says, "I can't put things together at all; I'm all thumbs." These kits are also fine for saving money and getting the satisfaction that comes from putting one's own system together.

There are 10 arm and turntable kits on the market now (6 turntables, 4 arms). Any one can be assembled in much less time than any electronic kit —30 minutes to an hour approximately.

We assembled most of the kits listed in the two charts just to see how they went together. Most of them could be assembled even without the carefully written and clearly illustrated instructions supplied. Only a screwdriver is required in most cases. Even a soldering iron is unnecessary with the turntable kits, since electricians' "wire nuts" are used for ac power connections between line cord, motor, switch and click-suppressing capacitor (supplied with five of the six turntable kits).

Turntable kits

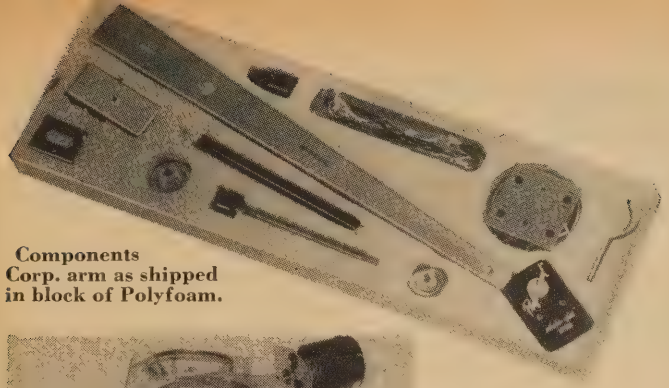
There has been a strong trend toward belt drive in transcription turntables in the last year or two. This is especially evident in the design of the kits, where we find five of the six using belts. This has two advantages. First, the belt isolates the motor, major source of turntable noise, from the frame or motorboard on which the pickup is mounted. Second, assembly of a belt drive is much easier and more reliable than precision gears and idler fitting or positioning.

Because belt drive is such a simple system, the five turntables using it have a strong resemblance to each other. Each has about a dozen parts, plus miscellaneous tiny components and a few small nuts, screws and springs. The major parts they all have are the turntable, a machined well to take the turntable's shaft, the motor, an assembly to shock-mount and partially isolate the motor, a metal motor board to hold the motor and turntable shaft well, and a belt to transfer power from motor to turntable. Each also has a click-suppressing capacitor, a switch and a line cord.

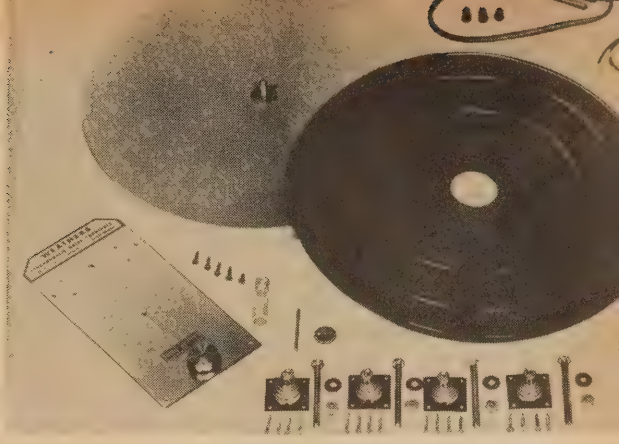
The only kit which doesn't use belt drive is the Weathers. It has a small soft-rubber wheel mounted on the motor shaft. Its rim drives the turntable directly. It uses a light turntable and a small 12-pole synchronous motor.

All six turntable kits are single-speed (33⅓ rpm), although the Thorens kit, like its factory-assembled older brothers, has a control knob allowing variation of the standard LP speed from about 30 to 36 rpm. The Rek-O-Kut K-33 has a belt-tension adjusting screw which may be employed to make similar minor adjustments in the turntable's rpm, although the primary purpose of this adjustment, which is ordinarily concealed under the decorative cover, is to allow precise adjustment of the turntable to exactly 33⅓ rpm when it is installed. Rek-O-Kut and Thorens have thoughtfully provided a stroboscope disc right on the turntable.

Each of the belt-driven kits has a turntable whose effective mass has been made as high as economics permit. The Rek-O-Kut, Gray and Thorens turntables are machined metal with as much weight as possible concentrated at the outside. The Components turntable is cast from what appears to be a special ceramic material, very heavy, which rings almost like metal when struck.

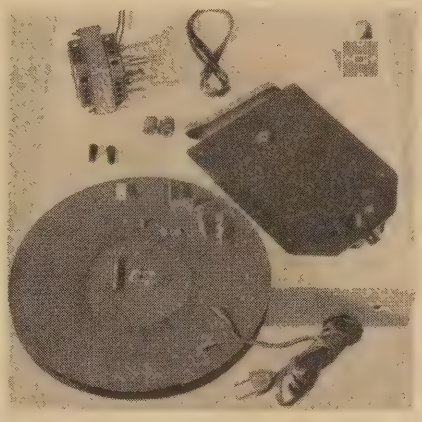


Components Corp. arm as shipped in block of Polyfoam.

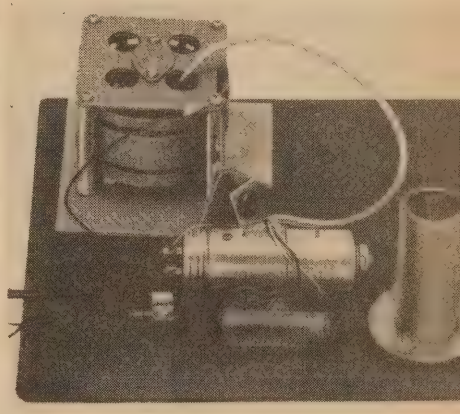


All parts of the Weathers low-mas turntable spread out prior to assembly

The 10 major pieces of Rek-O-Kut K-33 kit spread out on its mounting board prior to assembly.



All parts of Components Corp. turntable.



Underside of Gray turn table kit after assembly

Two of the units employ hysteresis synchronous motors. Each of these kits cost $10 to $20 more than the other models. In earlier years, one always tried to purchase a turntable with a hysteresis synchronous motor, if finances permitted. Today many experts agree that the design and mounting of the turntable can and often does lower rumble more than simply upgrading it by substituting a synchronous motor for a four-pole induction motor.

The hysteresis synchronous motors used in the Gray and the Rek-O-Kut (K-33H only) kits are both of the outside-rotor type, and may be driven with electronic power supplies to get any speed from below 33 rpm to over 78.

Because turntable manufacturers purchase the wood bases and motor boards in fairly small quantities (in terms of furniture quantities), the price

Thorens TDK-101 kit.

Gray viscous-damped arm had most parts of any arm kit.

TURNTABLE KITS
(all 33⅓ rpm)

Make and Model	Speed Adjustment	No. pieces, excluding nuts, screws, etc.	Sync motor	Price of base	Kit Price
Components Corp.	no	9	no	$7.50	$29.50
Gray HSK-33	no†	14	yes	$17.95*	$49.50
Rek-O-Kut K-33	slightly	10	no	$8.95*	$39.95
Rek-O-Kut K-33H	no†	11	yes	$8.95*	$49.95
Thorens TDK-101	yes	12	no	$9.00	$47.50
Weathers	no†	6	yes	$5.95	$49.95

*Company can supply flat motorboard for mounting turntable at less than $5.00.
†Complete range of speed available with variable frequency electronic power supply.

PHONOGRAPH ARM KITS

Make and Model	Construction	Interchangeable heads or slides	Number of pieces	Price
Audax KT-12	inertially balanced	yes @ $3.95	8	$15.50
Audax KT-16	inertially balanced	yes @ $3.95	8	$18.50
Components "Pro"	inertially balanced	1 screw, 3 or 4 terminal clips @ $2.00	13	$ 9.50
Gray SAK-12	viscous damped	yes @ $4.60	16	$23.95

of these bases are often a large proportion of the total price of the turntable. They become even more expensive, proportionately, when mounting a turntable kit.

Fortunately, turntable-kit makers provide full-size paper templates for cutting one's own mounting board or base. It may be reasonably assumed that most people who buy a turntable kit will seriously consider cutting (or having the local lumberyard cut) at least a motor board, since complete mounting bases run as much as $17.95.

Phono arm kits

Although the arms, in general, have no more parts than the turntables, and are smaller and cost less, they went together no more easily than the turntables. One touchy part was stringing the leads and soldering the cartridge terminal clips to them.

Three of the kit arms are of the type which is balanced without using springs. They employ a sliding weight near the rear end for adjusting the vertical tracking force. All the kits are supplied with arm rests.

The only kit of the lot which needs tools beyond screwdriver, soldering iron and pliers was the one for the Components arm. We needed a hammer to secure the main pivot to the body of the arm. Although the maker didn't supply a hammer, he did supply a large ball for the hammer to drive against the pivot in securing it!

Most technicians are aware that positioning the tone arm correctly in relation to the turntable is important. It is even more important for stereo than in reproduction of monophonic discs. In playing back stereo records, improper positioning cannot only produce distortion and extra record (and stylus) wear, as in mono playback, but can often introduce a serious loss in the separation between stereo channels.

The arm makers furnish full-size paper layouts for precise arm positioning on the wooden motor board or base. They should be followed religiously to minimize tracking error. END

HUM REDUCTION

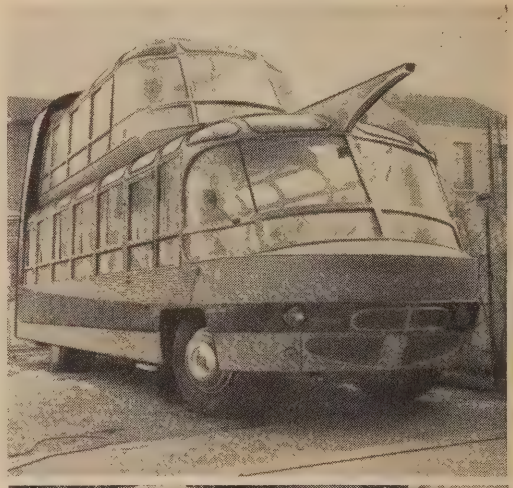
Dc heater supplies are undoubtedly the best way to eliminate ac hum. However, for small home amplifiers such a heater supply with its several large capacitors can turn out to be larger than the amplifier, and extremely expensive. An excellent substitute is to wire the heaters with shielded cable. At ordinary room volume, this reduces hum to inaudible levels.

For the best possible results, insulate the shield from the chassis at all but one point. Here a good ground connection is made. However, except for the finicky, this is not really necessary.

Of course, shielding the heater wiring is of no help when hum is introduced from some other source, so follow all good wiring practices as usual.—*R. C. Sandison*

CITYRAMA . . .
multilingual tourist bus

An electronic announcer describes points of interest to passengers in this Paris sightseeing bus in any of 8 languages

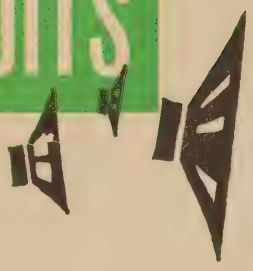


The big Citroen bus is fitted with a special 8-track tape recorder. The 8 languages are recorded on the 35-mm wide tape, which is started by the driver as the bus approaches points of interest. After a talk of a minute or two, it is switched to background music.

The bus carries 8 amplifiers and 8 preamplifiers to work with the wide 8-track tape seen here. A 470-ampere-hour, 24-volt battery supplies 110 volts ac through a rotary converter to power the setup. Tape machines for background music are also seen, as well as drawers for extra tapes, filed by language.

To avoid confusion, the speakers are placed in the seat head rests, so they can operate at a low level. A control box on the arm rest permits the listener to vary the volume within limits, and to select the desired language. Special announcements can be made by the hostess, seated at the front of the bus, who can switch in her microphone and override the recordings.

new developments in AUDIO CIRCUITS



Three interesting circuits: one reduces distortion caused by overmodulation and low signal strength; another is a phase inverter with exceptional gain, and the third is a TV video amplifier that doubles as a phono preamp

By ROBERT F. SCOTT
TECHNICAL EDITOR

THE current crop of radio and audio equipment is chock full of new and unusual circuits of interest to the technician. Those described here include a new circuit for reducing distortion caused by overmodulation and low signal strength in FM tuners, a low-distortion phase inverter with exceptionally high gain and a TV video amplifier that doubles as a phonograph preamp.

FM distortion eliminator

Critical FM listeners have often been annoyed by distortion that is noticed all too frequently on strong local stations and on those weak fringe-area stations that are invariably the favorites of many hi-fi fans. Distortion on strong signals is generally caused by overmodulation at the transmitter. When the FM transmitter overmodulates, the carrier swing exceeds the FCC maximum of ±75 kc and the resulting FM if carrier exceeds the linear portion of the discriminator curve.

Fig. 1-a shows a carrier with less than 100% modulation falling within the linear (150-kc) portion of the discriminator's response curve. Compare this with Fig. 1-b where we have a carrier with more than 100% modulation. The carrier now spills over onto the back slopes of the response curve and distorts the discriminator output as shown.

Fig. 2 compares weak (a) and strong (b) FM signals in the receiver's if bandpass. In Fig. 2-a, only those signals falling between 10.675 and 10.725 mc exceed the threshold of limiting and saturate the limiter(s). Those audio frequencies whose amplitude makes the FM carrier swing below 10.675 mc and above 10.725 mc will be distorted in the discriminator's output.

The DSR (*D*ynamic *S*ideband *R*egulation) circuit in the Knight KN-120 stereo tuner is designed to minimize the types of distortion just discussed. A portion of the discriminator's audio output is applied to the grid of the tuner's afc tube so the high-frequency oscillator is modulated in phase with the incoming audio. This reduces the frequency swing of the FM if signal by

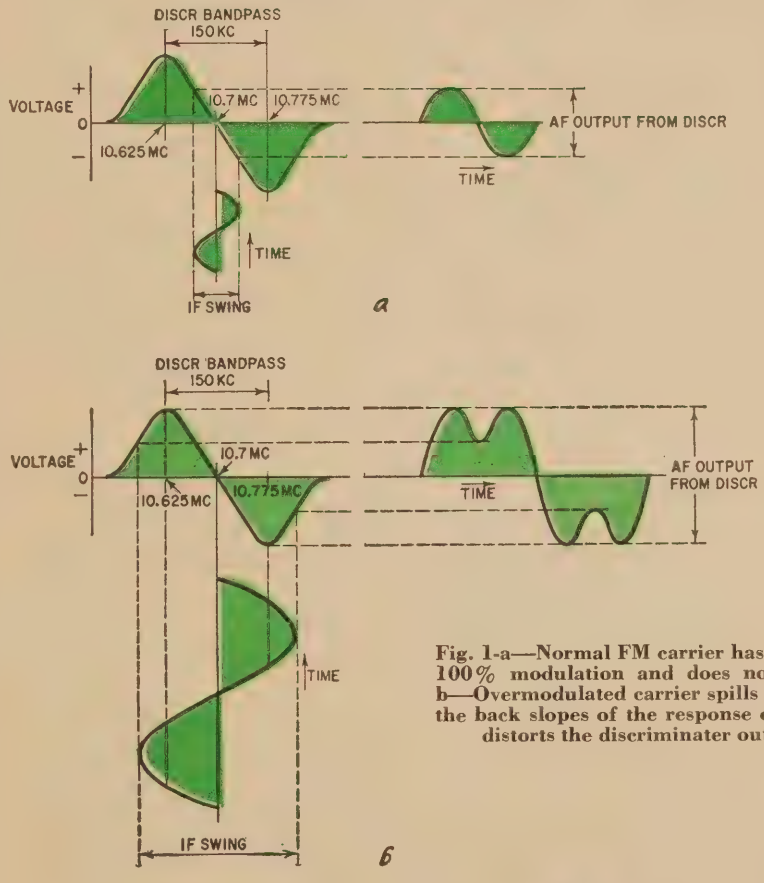


Fig. 1-a—Normal FM carrier has less than 100% modulation and does not distort. b—Overmodulated carrier spills over onto the back slopes of the response curve and distorts the discriminater output.

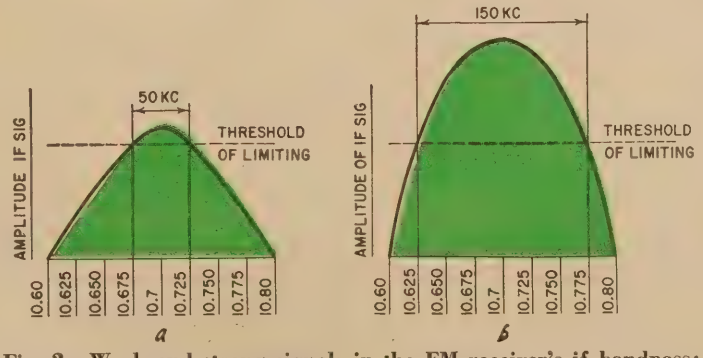


Fig. 2—Weak and strong signals in the FM receiver's if bandpass: a—only signals between 10.675 and 10.725 mc saturate limiter(s); b—with higher amplitude, signals between 10.625 and 10.775 mc saturate the limiter(s).

reducing the instantaneous difference between the oscillator and the incoming FM signal.

For example, consider a 98-mc FM carrier modulated by audio producing a swing of ±75 kc (from 97.925 to 98.075 mc). With the receiver's oscillator fixed at 10.7 mc above the carrier (at 108.7 mc), the if swings plus and minus 75 kc (from 10.625 to 10.775 mc). In a tuner without DSR or with the DSR turned off, the rf and if carrier deviations are equal.

Now, let's see what happens when we modulate the oscillator so its frequency swings in phase with the incoming FM signal. Assume that the instantaneous audio extracted from the discriminator swings the oscillator ±10 kc. Now, the oscillator frequency is 108.690 mc when the incoming signal hits 97.925 mc and rises to 108.710 mc when the FM signal swings to 98.075. Thus the DSR has reduced the if swing from 150 to 130 kc. Reducing the if swing has the same effect as reducing the transmitter's deviation or modulation by turning down the af gain control at the studio.

Thus with DSR, an overmodulated signal like that in Fig. 1-b would be compressed to fit within the linear portion of the discriminator's passband and distortion would be prevented. Similarly, the full swing of a weak signal (Fig. 2-a) can be compressed so it falls within the portion of the if response curve extending above the threshold of limiting so all distortion-producing residual amplitude modulation will be removed.

DSR circuit analysis

The circuit of the DSR is shown in Fig. 3. The discriminator's dc output is tapped off and fed to the reactance modulator's grid (afc tube) through a filter network composed of a .01-μf capacitor and 3.3-megohm and 470,000-ohm resistors. The discriminator's af output is fed to a cathode follower where a small portion is tapped off and fed to the afc grid through the .056-μf capacitor. This makes the oscillator swing in phase with the audio signal. To provide optimum performance with the DSR on, the 100-μμf capacitor is switched into the circuit to change the time constant of the de-emphasis network.

Since the oscillator must be tuned on the nose for proper DSR operation, the afc and DSR switches are interlocked so afc cannot be turned off while DSR is on.

Dynamic sideband regulation tends to provide the distortion-free performance of the wideband discriminator under varying signal and modulation levels while having the advantage of being less affected by sideband clipping in the if circuits.

The Knight KN-120 stereo tuner incorporates a DSR circuit in its design.

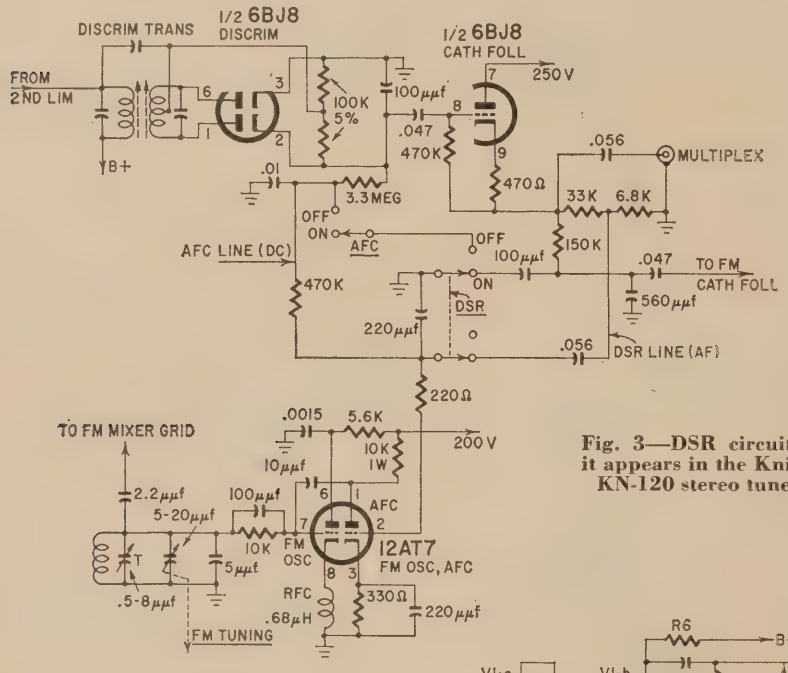


Fig. 3—DSR circuit as it appears in the Knight KN-120 stereo tuner.

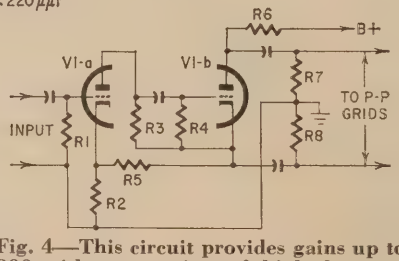


Fig. 4—This circuit provides gains up to 800 with attenuation of high frequencies. High-frequency losses are reduced when gain is lowered to 200–300.

High-gain phase inverter

Audio design engineers are constantly seeking new types of phase inverters that will provide higher gain and lower distortion than existing types. High gain means that fewer voltage amplifiers are required when the amplifier is to be driven by low-level signals. With fewer stages, phase shift is reduced and heavier negative feedback can be used while maintaining a high margin of stability.

Some designers use a high-gain inverter with comparatively high distortion and then reduce distortion with negative feedback. Others prefer a low-distortion inverter, even if its gain is very low. Typical examples of these two schools of thought are the various forms of paraphase and long-tail inverters frequently used in high-quality amplifiers. A typical floating paraphase inverter with an ECC83/12AX7 has a gain of 58 to 62 with distortion ranging from 3.5 to 5.5%. A long-tail pair with the same tube and range of plate voltages has a gain of 25–27 with 1.8% distortion.

Design engineers at Amperex Electronic Corp. have developed a new form of split-load inverter in which a weird combination of positive and negative feedback is used to obtain exceptionally high gain with reasonably low distortion. The circuit in Fig. 4 provides gains up to 800 with considerable attenuation of frequencies in the upper end of the audio range. High-frequency losses are reduced in practical circuits when gain is reduced to 200–300.

In Fig. 4, the plate of V1-a is fed through R3 from V1-b's cathode. Negative feedback is applied to V1-a by R2 the unbypassed cathode resistor. The low-potential end of cathode resistor R5 is returned to V1-a's cathode and develops a positive feedback voltage across R2. The positive feedback voltage across R2 exceeds the negative

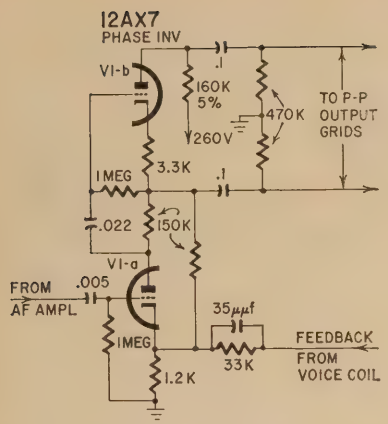


Fig. 5—High-gain phase inverter as used in Admiral's 5T4-A amplifier.

S1-a of the TV–PHONO switch disconnects the grid circuit of the video amplifier from the video detector output and connects it to the phono input terminals. The shield of the cable from the arm of S1-a to the .047-μf blocking capacitor is grounded through L206, L201 and R214. S1-b connects the output of the video amplifier to the high end of the volume control in the grid circuit of the 12C5. S1-c connects a 50-μf capacitor across the video amplifier's cathode resistor to reduce degeneration and provide a 6-db boost in the amplifier's gain at audio frequencies.

S1-d breaks the 115-volt line to the tuner and the screen grid of the vertical output tube and connects 115 volts directly to the cathode of the picture tube. Removing B plus from the tuner prevents rf signals from being picked up and possibly feeding into the audio circuit through stray inductive or capacitive coupling. Connecting 115 volts to the cathode of the picture tube cuts it off and prevents flashes of light from appearing on the screen when the set is turned on or off with S1 in the PHONO position.

A remaining section of S1 (not shown) breaks the 135-volt line feeding the vertical output and damper plates and the screen grid of the horizontal output circuits. Cutting off the horizontal amplifier removes the boosted B-plus voltage source that supplies the horizontal and vertical oscillators and the FM detector. With the deflection circuits fully disabled, there is no possibility of 60- and 15,750-cycle sweep signals causing audio interference.

The TV–phono combination is supplied with a monophonic cartridge but can be readily adapted for stereo by adding a stereo cartridge and an auxiliary amplifier–speaker unit. END

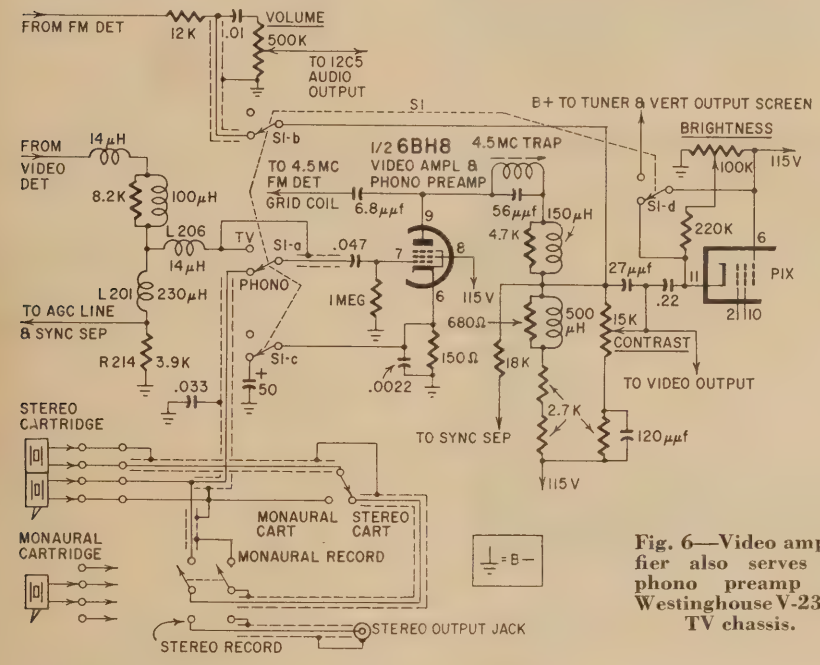


Fig. 6—Video amplifier also serves as phono preamp in Westinghouse V-2365 TV chassis.

feedback voltage and V1-a would tend to be unstable if its plate load resistor (R3) were not connected to V1-b's cathode. However, since R3 returns to V1-b's cathode and V1-a's plate and V1-b's cathode are in phase, enough negative feedback is applied to give the circuit complete stability.

Fig. 5 is the circuit—including schematic layout—as used in Admiral's 5T4-A amplifier chassis. Gain is around 200. The circuit is further stabilized and its response widened by applying negative feedback to V1-a's cathode from the output transformer's secondary.

Audio–video amplifier

The Westinghouse V-2365 TV chassis is designed so its audio system can be used as one channel of a stereo system. However, since the 12C5 output tube is fed directly from the FM detector, it was necessary to provide a phono preamplifier. It was done by using the video amplifier, as shown in Fig. 6.

When switching to PHONO, section

LOWS ARE DIRECTIONAL TOO

TWO General Electric engineers have rescued the low-frequency part of the audio spectrum from the charge of nondirectionality so often made by stereo specialists. The listener will breathe a sigh of relief, for not only does this confirm the (occasional) evidence of his senses, but marks a reversal in the trend toward whittling away the stereo frequencies.

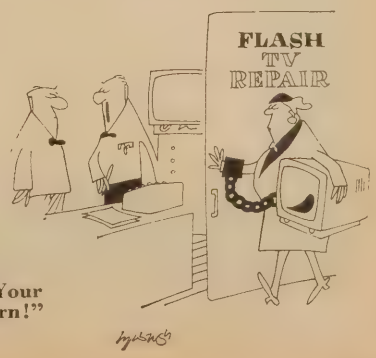
Resigned to the idea that "nothing under 200 cycles is directional," he has been willing to accept without argument the extension of that area up to 300 cycles. But with one West Coast stereo system basing itself on "experimental proof" that the frequencies *above* 2,500 cycles contribute little or nothing to stereo, the enthusiast had reason to fear his band might shrink to a point frequency. Now the tide has turned, and the stereo spectrum is increasing rather than decreasing.

The two engineers, W. H. Beaubien and H. B. Moore, conducted carefully controlled tests with 29 listeners to see if they could tell from which speaker the low notes came. They made an elaborate setup to (a) pass full stereo information through two wide-range speaker systems separated about 10 feet, and (b) to pass full audio information through the same speakers after combining it through special circuitry to eliminate directionality.

They also used high-pass filters to emphasize the lows. Directional perception among the 29 people tested, using musical material below 100 cycles, was 80%. This appeared to indicate a high degree of directional perception at the low frequencies, in contrast to previous tests made *with continuous sine waves.*

The room in which the experiments were conducted was similar in size to a large living room, with a high ceiling (12 feet). Speakers were placed along the sides, pointing toward the center of one end. The listeners were positioned near that end, 10 feet from either speaker.

The two men delivered a paper on their experiments at the Audio Engineering Society (AES) convention. END



"Your turn!"

HOW VALID ARE SPEAKER RESPONSE CURVES

Do they really mean something or are they just a heap of meaningless confusion intended to sell speakers?

By GEORGE L. AUGSPURGER

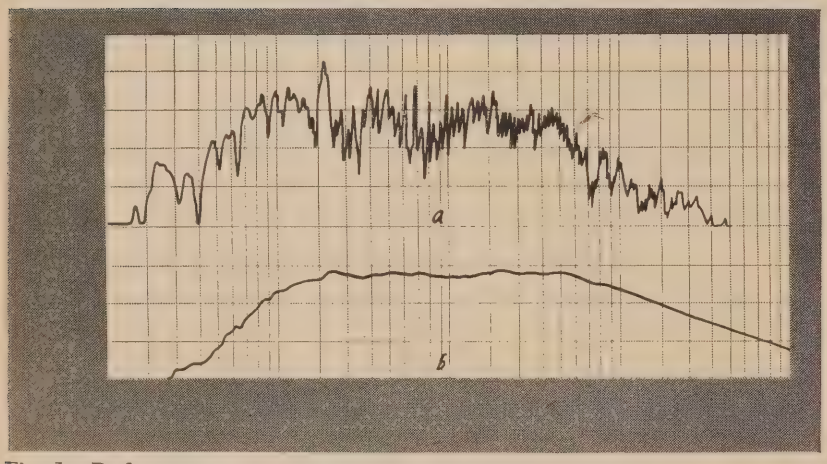


Fig. 1—Both curves are run under identical conditions, but with different chart and pen speeds. Note how the higher speed smooths out the curve.

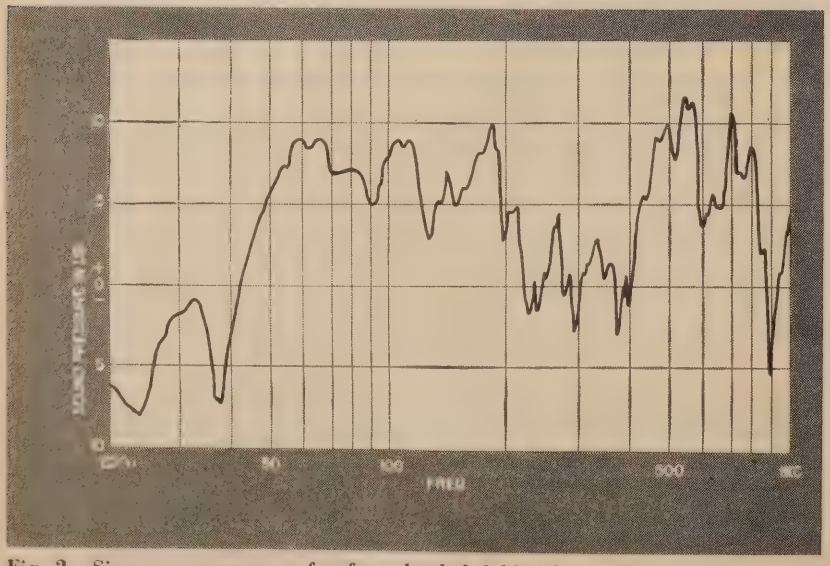


Fig. 2—Sine-wave response of a front-loaded folded horn. The microphone pickup was placed 3 feet from the horn mouth and on its axis.

THE myth that high-fidelity reproduction is directly related to frequency response is an article of faith the audiophile seems unwilling to give up. Irresponsible statements in hi-fi primers and consumer publications haven't helped. The truth is that most of the time "frequency response" is an almost meaningless term, and at best is just one of the many factors that relate to what we call realistic sound reproduction.

Those who have suffered most from the emphasis on response curves are speaker manufacturers. Talking about a speaker's frequency response just isn't the same as going over a power amplifier. Nevertheless, when Joe Decibel hears the new Stereonic Triple Piston speaker system at the audio show, his first reaction is, "Sounds great! What's its frequency response?"

The person in charge generally sighs and assumes the question is pure noise from a semantics standpoint—something like "How do you do?." And the answer is simply another part of the ritual, "20 to 20,000." No speaker manufacturer at an audio show has the slightest hope of persuading the audiophile that there is really no truthful, yet simple, answer to his question.

However, a verbal white lie is not the same as publishing an impressive chart with lots of squiggly lines and the notation "machine-run frequency response curve." How valid are such curves? Can they be used as a basis for comparing and selecting speakers?

Standards for measuring speaker frequency response do exist and the measurements made are, within reasonable limits, repeatable. Mr. Villchur has been hammering at this for several years and publishing quite honest curves complete with details on how they were made.

But, even if we had such data available—measured under identical conditions—for every speaker on the market,

there is still no assurance that this mass of material would agree with listening tests made in the customer's home. In the first place, frequency response by itself is not enough. Beranek states that frequency response is only one of seven characteristics which are required to describe the performance of a loudspeaker.[1]

He further warns, "The use of a pressure microphone has the disadvantage that it is a 'monaural' (one-ear) device, whereas we ordinarily listen to sound 'binaurally' (two ears). . . . We must expect, therefore, that our 'monaurally' measured response curve will not bear an exact relationship to what a listener would perceive if he were in the same location as the microphone." [2]

Even charting a response curve is not cut and dried. All sorts of things affect the way such a curve turns out.

Making response curves

Loudspeaker response curves are generally run by feeding a sine wave to the speaker, picking up the sound with a calibrated microphone, and feeding the signal to some sort of measuring device. We can connect the mike to a VU meter and laboriously plot a curve point by point, or we can use a graphic recorder to do the job automatically. The photo shows a very elaborate version of such a machine.

That the characteristics of this device will affect the final curve just as much as the speaker under test is seldom mentioned. The relationship of the speed at which the curve is run to the rapidity with which the pen can follow abrupt changes determines how much peaks and dips in the response are averaged out during the course of the test.

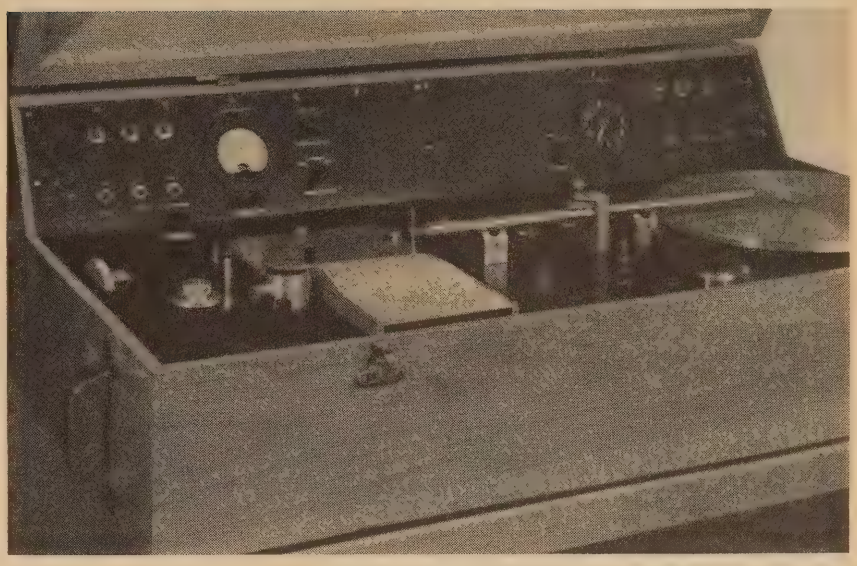
There is always some degree of smoothing, and this is all right so long as we know it is present, but we must also know how much. For example, Fig. 1 shows two curves run on the same speaker under the same physical conditions on the same machine. They are both legitimate curves if we know how the machine was set. But what is too often done is to say nothing about the method other than it is "automatic," and simply publish the better curve.

Acoustic surroundings

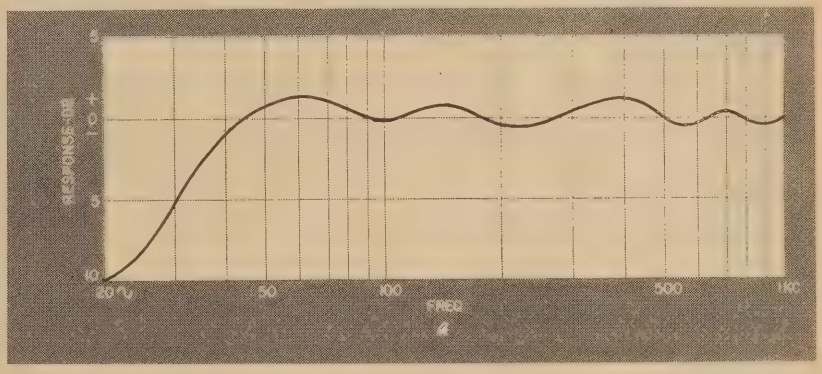
Speaker tests are usually run in free-field conditions—acoustic reflections are eliminated so far as possible to get an honest indication of the speaker's performance. But is such a curve really honest? How many of us listen to hi-fi in an anechoic chamber?

The purist will say this is a childish objection. If the speaker won't perform well in open space, it certainly won't be any better in an average room and, after all, free-field testing is the only way we can get a standard of comparison. The opposing position is that this may be the only standard we have, but from the consumer's point of view it is a pretty poor one.

The basis for my viewpoint is that different speaker systems behave dif-



An automatic loudspeaker-response chart recorder. This unit has three speeds.



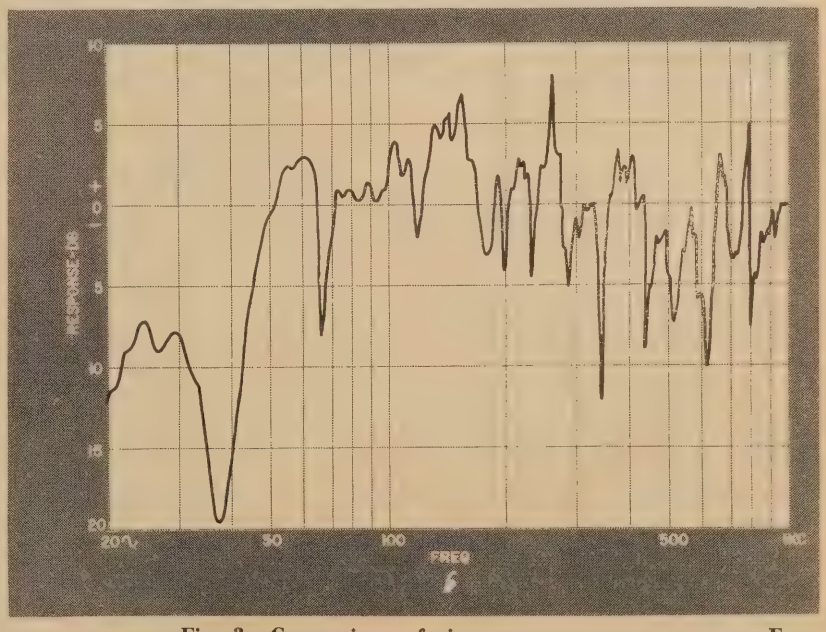


Fig. 3—Comparison of sine-wave response curves: a—Free-field curve published by speaker manufacturer; b—curve run with speaker in corner of listening room. The microphone pickup was placed 3 feet from the speaker on its axis.

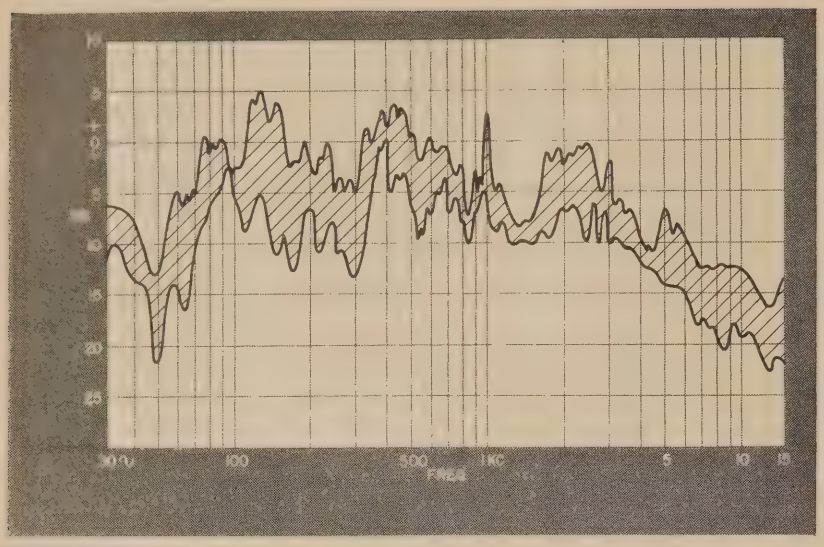


Fig. 4—Variation of pressure response of an 8-inch speaker in a small baffle. Unit was set up in a listening room at floor level. Shaded area shows maximum variations in sine-wave pressure response curves at five microphone positions.

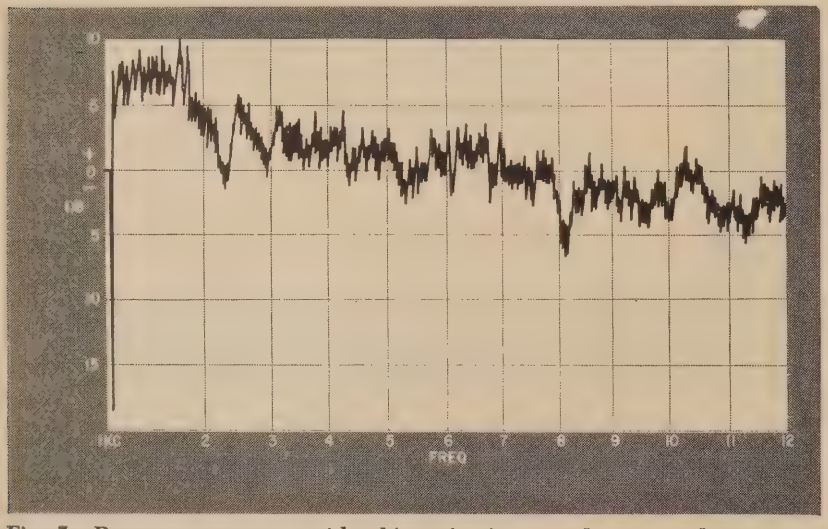


Fig. 5—Response curve run with white-noise input and wave analyzer.

ferently when moved from an anechoic chamber to a listening room. For one thing, it is not generally realized that standing waves not only affect what a listener hears (depending on where he is sitting), but actually influence the physical motion of the speaker cone.

Some designs are what might be called socially adaptable—if they run into a strong standing wave at some frequency, they obligingly change their intensity. Others (usually the more efficient horn-loaded designs) are rugged individualists who maintain their output regardless of acoustic environment.[3]

A second consideration is that a system which has a large sound source is generally less affected by room acoustics than a small one. A large corner-horn or multiple-woofer array will often give better results in a small listening room than a more compact unit of comparable quality, even though common sense suggests that the opposite should be true.

A third factor is that the corner horn is designed as an integral part of a room and cannot be measured under conditions equivalent to free space. So it is easy to see why a comparison of response curves for these two kinds of systems is bound to be more a guessing game than a scientific analysis.

The pitfalls of such comparisons are illustrated in Figs. 2 and 3. Fig. 2 is the sine-wave response curve of a folded corner horn measured in a 15 x 27-foot listening room. Compare it to Fig. 3-a—the published response of a sealed "acoustic-suspension" system measured in free air (radiating into a 180° solid angle). In this instance, there is no reason to doubt the honesty of the published curve since the manufacturer specified the exact conditions under which is was run.

Any normal audiophile, shown these two curves, would not hesitate an instant to pick the sealed box as the "better" of the two speaker systems.

But now let us move the small box indoors and measure it under the same conditions which give us the curve for the corner horn. The miserable affair of Fig. 3-b is the result! The reason for this surprising change of behavior is a combination of the three factors just discussed.

True, the small system can be used in a variety of room locations, while the horn is restricted to corner placement. But a number of tests indicate that no matter where the small speaker is placed in this particular room, its measured curve is never significantly smoother than that shown.

Mr. Paul Klipsch would probably say this experiment shows why a corner horn is better than a direct radiator. Mr. Villchur can undoubtedly argue the opposite. (My own feeling is that **either system can be very, very good under proper conditions.**) But the only important point here is that comparing these two designs on the basis of published sine-wave response curves is grossly unfair.

Sometimes, rather complex methods are used to measure a speaker in a room, yet to average out room effects so that the resultant curve corresponds with listener evaluation. Jensen loudspeaker engineers sometimes use five microphones placed at various locations. The outputs from these are averaged automatically and fed to the chart recorder.

Another method is to plot several curves at various mike locations, and then graph maximum and minimum output at all frequencies. Such a graph is shown in Fig. 4. The shaded area indicates maximum variations between five microphone positions for a single 8-inch speaker in a very small enclosure.

One final remark on acoustic surroundings. Even elaborate anechoic chambers can be made to yield different curves with a little juggling. Two laboratory technicians for a highly reputable firm once spent a full week trying every conceivable location of microphone and loudspeaker in their anechoic chamber to get the smoothest possible curve for publication.

Source material

So far, we have assumed that the speaker was being fed pure sine waves at various frequencies. This is standard procedure, but not the only standard method. Warble tones or white noise are often used to show up characteristics not measurable by sine-wave tests.

The white-noise method is particularly interesting. The speaker is connected to a source of white noise covering the entire audio spectrum at a substantial power level. This means that the unit is trying to reproduce random bursts of every frequency simultaneously—a more difficult requirement than even the most dissonant modern music.

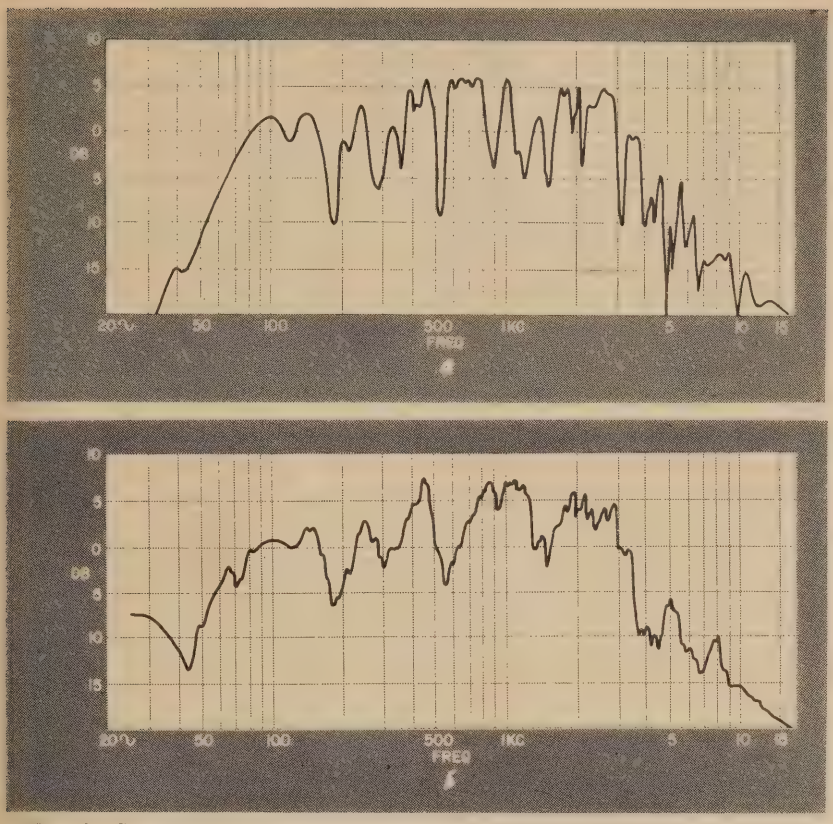


Fig. 6—Sine-wave vs white-noise response of 8-inch speaker in small cabinet in corner of listening room at floor level. Microphone pickup is placed 3 feet from the speaker on its axis: a—white-noise input; b—sine wave input.

The noise thus produced is picked up by a microphone and fed to a narrow-band variable wave analyzer. This is an expensive filter having a bandpass of only a few cycles, and continuously variable over the band of audible frequencies. While the speaker is struggling to reproduce everything at once, we measure what it actually is producing at each frequency.

Fig. 5 is a white-noise curve run on a high-quality tweeter. The continuous ups and downs of about 2 db are caused by random fluctuations of the source rather than any characteristic of the unit under test. Notice that the frequency scale is not logarithmic, and that the curve must be replotted for normal comparison purposes.

Fig. 6-a is such a curve redrawn from a white-noise and wave-analyzer recording. The unit under test was a cheap 8-inch speaker in a very small enclosure. Fig. 6-b is a standard sine-wave curve run on the same unit under identical physical conditions. Both methods supposedly measure the same thing, yet there is little similarity between the two curves!

Engineers who work with white-noise testing find that a speaker which has the same curve with white-noise as with sine-wave input usually sounds considerably better than one which may have a smoother sine-wave curve, but displays different characteristics when reproducing white noise.

The various methods described are some of the tests used to determine the frequency response of a loudspeaker. They are all in common use and are all valid, yet they may give significantly different results. Other characteristics are measured by other equally complicated methods. The goal of all this testing is to be able to correlate measurable response with listening evaluation so specific factors can be isolated for design and development work.

Consequently, we must admit that speaker response curves are valid—**for the engineer who made them.** Such tests are a valuable tool in improving loudspeaker design.

But it seems silly for the consumer to study test results which admittedly only approximate final listening evaluation. The audiophile isn't interested in building a speaker, he wants to buy one. And the only valid way to judge a speaker for music reproduction is to listen to it reproduce music.

Beware of the dealer who demonstrates with an audio oscillator, and who is eager to point out the unit which has *more* bass and *more* treble. This is like judging orchestras on the basis of which has more violins or louder kettledrums. Instead, listen to music you like in a relaxed atmosphere, and listen for the system which sounds most natural.

Once you own such a system, you can bask in perfect confidence when your jealous friends say, "Well, it sounds all right, but what's the frequency response?"

Like the Rolls-Royce owner, you calmly reply, "Adequate." END

[1]Leo L. Beranek, *Acoustic Measurements*, Wiley,, 1949, page 661.
[2]*Ibid*, page 666.
[3]A. L. Thuras, "Loudspeakers and Microphones for Auditory Perspective," *Bell Laboratories Record*, Vol. 12, No. 7, March 1934;
Reprinted in *Audio*, October, 1957.
"The problem then is to select an internal (amplifier) impedance such that variations of power output with load impedance shall be minimum. . . . The load impedance will vary accordingly as the outgoing waves are met by aiding or opposing pressure from the returning waves. . . . Hence rather large variations in sound output would have to be tolerated were it not for the smoothing effect of properly chosen electrical impedance. . . . An essential condition for this is the high efficiency of the low-frequency loudspeaker."

WHEN IT COMES TO YOUR PROTECTION . . .

Radio-Electronics is just as fast on the draw as Matt Dillon, Wyatt Earp or any of real, reel, or TV marshals on the Old West. For instance—for the last 51 issues (since January 1956) we have refused all mail order tube advertising which did not state specifically that the tubes advertised were new and unusued, or seconds, rejects or otherwise sub-standard if that were the case. Pardner, that has cost us plenty of pesos in lost advertising space—but we think it was straight shooting—and as long as it has protected you, it's been worth it.

DESIGN YOUR OWN PREAMP

Part III—A 2-stage feedback tone control

By NORMAN H. CROWHURST*

FEEDBACK can be applied in a variety of ways to produce tone-control effects. The simplest, as we discussed last month, is the single-stage arrangement, with the normal passive network "inverted" in the feedback connection. But proper use of feedback can produce effects not possible with simple passive circuits. Fig. 1 shows one example.

By choosing the right parameters, the circuit gives an accentuated rolloff below the bass-boost frequency. This can help eliminate rumble—a feature that bass boost is apt to emphasize! Also this circuit permits maximum boost to work with a progressively sharper slope, considerably exceeding that possible with passive circuits (Fig. 2). First we'll explain how the circuit works, then how the values are calculated to get the required response.

*Author: *High-Fidelity Circuit Design* (Gernsback Library).

How it works

Mid-frequency gain is held very nearly constant by the overall feedback resistors R9, R10 with R3, R11. But there is also an internal loop, using R5 from the slider of R7. Varying this internal loop with R7 effectively varies the gain of the pentode stage. As R7 is varied, the amount of feedback produced by the outer loop changes, to keep the overall gain constant. This change in amount of feedback alters the interaction effects, so the response can be made to vary between bass boost and bass cut. More of that in a moment.

For high-frequency control, the conventional "inverted" arrangement is applied, using C4 to give boost by reducing high-frequency feedback, and C6 to give cut, by increasing the high-frequency feedback. Now we'll go through the calculations that get everything happening at the right place.

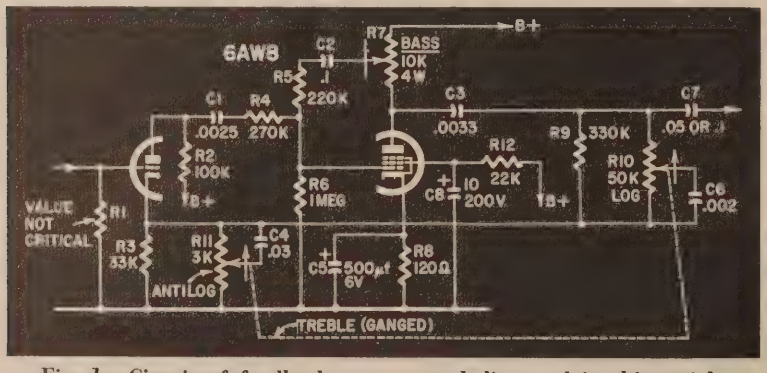


Fig. 1—Circuit of feedback tone control discussed in this article.

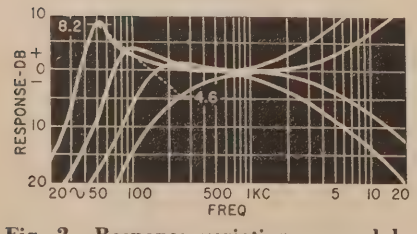


Fig. 2—Response variation covered by the circuit in Fig. 1.

The triode section of the 6AW8 has a 100,000-ohm dc load resistor and is coupled to R4, R5 and R6, for ac load, which parallel to look like about 470,000 ohms. The bias resistor is 33,000 ohms in parallel with 3,000 ohms, which is about 2,700 ohms. This produces a gain in the triode section of about 40. (This can be determined from load-line construction or the tabulation in a tube manual—whichever is convenient.)

Feeding the audio output from the triode section through R4 to the pentode grid attenuates some of this gain. (R4 is needed to isolate the stages so the internal feedback loop gives satisfactory control and does not make the triode stage distort.) The net gain, from the triode's grid to the grid of the pentode, without any feedback, works out to about 16.

The pentode section, with a 10,000-ohm plate resistor, 22,000-ohm screen feed resistor (well decoupled with 10 μf, to avoid affecting the feedback response) and 120 ohms bias (also well bypassed with 500 μf) gives a gain of 70. Feedback resistors R9 and R10 act as an ac load for this plate, reducing its no-feedback gain to about 56. So the maximum no-feedback gain of the two stages comes out to 16 times 56, or almost 900.

With R7's slider at the top, there is no internal-loop feedback, and 900 is the gain before the outer-loop feedback cuts it down. With R7's slider at the bottom end, internal-loop feedback is maximum. C2 is large enough not to affect the response within the active range. The voltage fed back to the pentode grid, via R5 in series and R4 and R6 as parallel termination, is half the audio voltage at the pentode plate. This now limits the pentode's effective gain to 2, or the two stages to 32.

Turning potentiometer R7 changes the internal gain from 32 to 900. The outer-loop feedback uses R9, R10 and R3, R11. The first two parallel to 43,000 ohms, while the last two parallel to 2,700 ohms, giving a feedback fraction of $\frac{2.7}{43 + 2.7}$, or about 1/17. So the net outer-loop gain varies from 32/17, or about 1.9, to 900/17, or about 53. This is the variation of $A\beta$. The feedback factor is $(1 + A\beta)$, so it will vary from 2.9 to 54. In db, this is 9.2 to 34.6.

Selecting circuit values

To see what can be done with this, we need the chart of Fig. 3. The response shaping depends on the amount of feed-

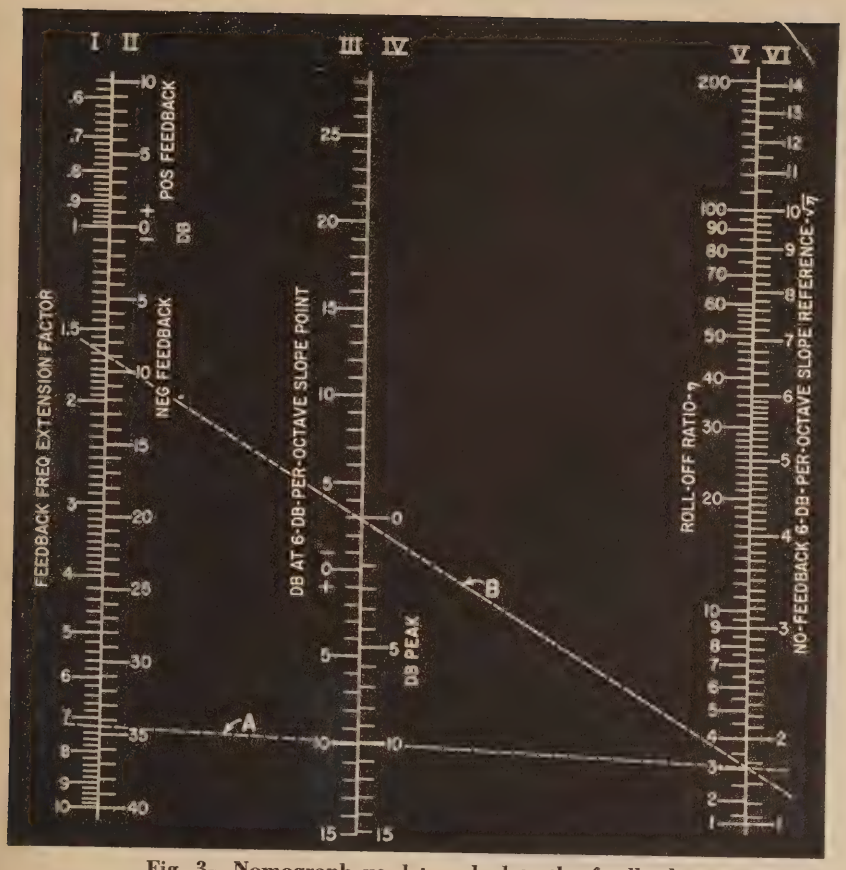


Fig. 3—Nomograph used to calculate the feedback parameters for this type of tone control circuit.

back and the ratio between the internal rolloff frequencies (in this case set by C1 and C3). The db response at a reference frequency (to be explained below) is given on the center scale when a straightedge is laid between the values of feedback at the left and rolloff ratio at the right.

Let's assume we want a maximum boost of 10 db. This occurs with maximum feedback (34.6 db). Using the chart, we line up our straightedge with 34.6 on scale II (the amount of negative feedback) and 10 on scale III (the desired boost at the unity-slope reference frequency) and where this line (A) cuts scale V we read the rolloff ratio to be 3. Now, using the same rolloff ratio (3), and 9.2 db of feedback instead of 34.6 to plot line B on the chart, we find that we are 3 db down at the unity slope reference frequency. As this means only the minimum position will avoid peaking at all, let's try again.

Choosing a rolloff ratio of 6, the 9.2-db feedback gives 4.6 db down at unity slope reference frequency, while 34.6-db feedback gives 8.2 db up at the reference frequency. But don't conclude that this is all the variation you get—from +8.2 db to −4.6 db at the same point.

That reference frequency

That's not all there is to it. Changing the feedback shifts the reference frequency as well as changing the response shape. Let's see what this reference frequency is and how it is arrived at.

Without feedback, the two couplings have rolloffs related by a predetermined ratio—we have tentatively settled for 6. Without feedback, the unity slope reference frequency is at the geometric mean between these rolloffs (Fig. 4). At this frequency, the slope is exactly 6 db per octave. The spacing between each rolloff frequency and the reference frequency is $\sqrt{6}$, or about 2.45.

Now feedback is added, which extends the reference frequency outward. With low-frequency rolloffs it goes downward. The left-hand side of the left scale of Fig. 3 tells how much (the ratio). With 9.2-db feedback, the shift is a factor of 1.7. With 34.6-db feedback, it is 7.3.

Assume now we settle for an 8.2-db boost at 50 cycles. This means 50 cycles is the no-feedback reference frequency divided by 7.3. Or the no-feedback reference frequency is 7.3 times 50 cycles—365 cycles. Going to the other

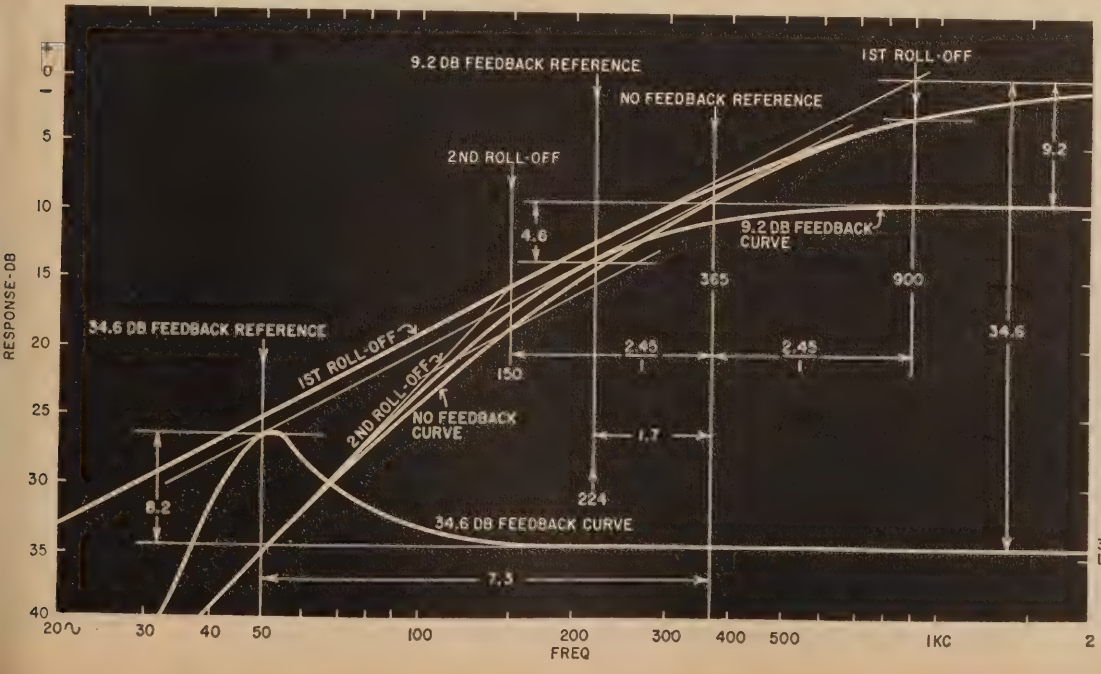


Fig. 4 — Construction evaluated with aid of Fig. 3. Vertical dimensions are db; horizontal ones are ratio between the frequencies indicated, in accordance with data on nomograph of Fig. 3.

extreme of the control, the frequency is shifted only by a ratio of 1.7. So the response is now 4.6 db down at $\frac{365}{1.7} = 224$ cycles. Which means at 50 cycles the response is about 25 db down (Fig. 2). This seems like a good range, so let's complete the design.

The no-feedback reference frequency is 365 cycles, to get the range we have figured out. So one rolloff needs to be 365/2.45, the other 365 × 2.45. This makes the rolloff frequencies 150 and 900 cycles.

Coupling capacitor C1 is calculated to give a rolloff at 150 cycles. To do this, it should have a reactance of about 500,000 ohms at 150 cycles, this being the total effective resistance in series with C1. A value of .0025 μf comes close enough. C3 is calculated to give the other rolloff at 900 cycles. It needs a reactance of 52,000 ohms at this point, for which .0033 μf will serve.

The high-frequency control merely bypasses either the top or bottom of the outer-loop feedback network, with C4 or C6, according to setting. Design aims at making maximum boost or rolloff start at 2,000 cycles.

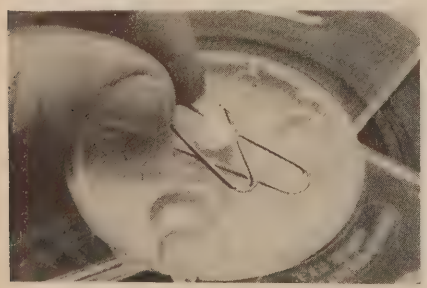
For boost, C4 will bypass all of R3 and R11, so it needs to have a reactance of 2,700 ohms at 2,000 cycles, for which .03 μf will serve. For cut, C6 needs to have a reactance of 43,000 ohms at 2,000 cycles, requiring about .002 μf. By using ganged log and antilog tapered potentiometers, an approximate mid-position will result in each capacitor bypassing only about one-tenth of the total resistance, yielding a flat response out to 20,000 cycles, because the feedback does not change appreciably.

Now that we have concluded our study of tone-control circuits, next month we will go on to discuss the volume- and loudness-control section of the preamp.

TO BE CONTINUED

TAPE RECORDER KINK

To keep tape reels in place when the regular spindle bushings for this purpose are not available, try paper clips. Use one ordinary paper clip for each tape spindle. Spread the clip slightly in



the center and force it down over the spindle as shown in the photo. It will hold a full-size reel in place without difficulty. Do not push the clip too far down on the spindle or it will cause noisy recorder operation.—*Glen F. Stillwell*

FEED TV AUDIO into HI-FI SYSTEMS

How to get high quality sound from your TV set

By GEORGE B. LEONARD

THERE are many approaches to connecting television audio into a hi-fi system. All seem to have the same two problems. First, there is the technical problem of maintaining proper treble response over the interconnecting cable. Second, there is the family relations problem to overcome when you start adding tranfer switches to the family TV for switching the audio from its internal amplifier to the external system.

I tackled the technical problem first. I started by connecting a length of microphone cable from across the TV's volume control to the hi-fi amplifier's tuner input to see what would happen. The treble response was lost in the cable as I expected, but I was happy to find that no noticeable hum was introduced.

Next, I measured the capacitance of the interconnecting cable, which was about .0025 μf for the 20-foot length. The solution suddenly came to me. The capacitance of the inner conductor to the shield of the cable was typical of what would normally be used as the shunt capacitance of the 75-μsec de-emphasis filter in the receiver (Fig. 1). Connecting the cable in place of the capacitor would solve the problem (Fig. 2).

All TV receivers use an R-C filter with a time constant of approximately 75 μsec to de-emphasize the treble response which is pre-emphasized a similar amount at the transmitter. The de-emphasis filter in almost all receivers is located just ahead of the volume control. The shunt capacitance leg of the filter can usually be found paralled across the input to the volume control.

Reducing the set's shunt capacitance by an amount equal to the added capacitance of the cable will not change the receiver's characteristics. The tuner input of a typical hi-fi amplifier has a 1-megohm series resistor which isolates the amplifier input from the cable so the amplifier has a negligible loading effect on the cable or receiver.

Some TV receivers do not use a de-emphasis filter with a time constant of exactly 75 μsec. The manufacturer, for example, might correct for the excess treble that might be produced with a pentode output tube into an undersized speaker. Increasing the time constant to, say, 100 μsec would make the receiver sound less brilliant. If you are feeding the TV audio into the input of a good amplifier, use a time constant that is corrected to 75 μsec. Correcting this in your receiver will probably make the TV's audio output sound better too, since there is a tendency for manufacturers to overcorrect for output that is on the brilliant side.

To calculate the time constant of the filter in your set, multiply the shunt capacitance of the filter in microfarads

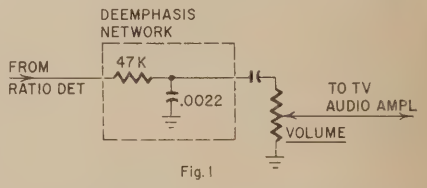


Fig. 1—Cable capacitance turned out to be about the same as the value of the capacitor in the TV set's de-emphasis network.

by the series resistance in ohms to obtain the time constant in microseconds. The series resistor in most receivers is the resistor feeding the high side of the volume control. The shunt capacitor will then be found connected from the high side of the volume control to ground.

The second problem, that of family relations, was automatically solved by

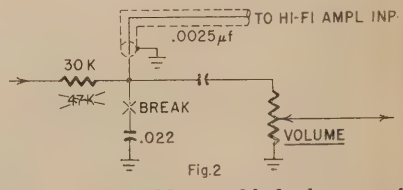
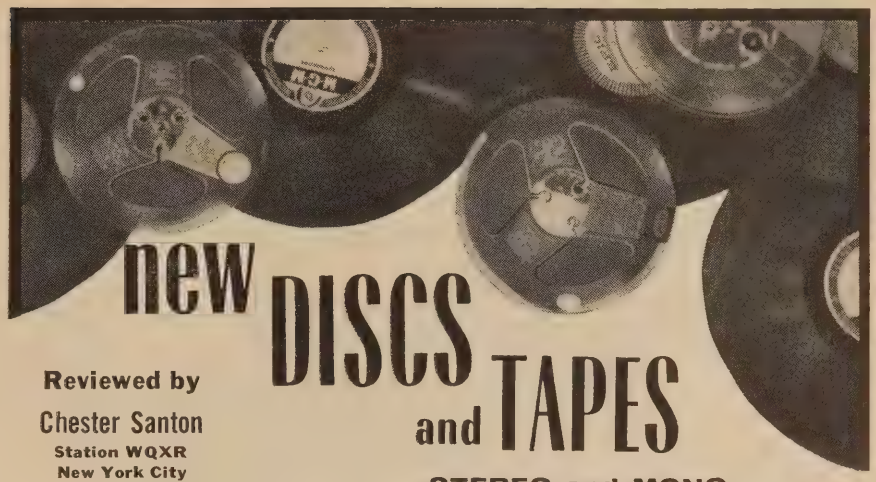


Fig. 2—The cable is added, the capacitor remove and resistance value changed to hook up the TV audio output.

using this method. No changeover switches are required. If we want TV independently of hi-fi, we simply turn on the TV. Then for hi-fi audio from the TV we simply turn on the hi-fi amplifier and turn the TV volume control to zero. Also, a nice pseudo stereo effect may be obtained by using both outputs of audio at once (the TV set as one "channel", the hi-fi amplifier as the other).

This system must not be used to connect a hot-chassis TV set to an external amplifier. For hot-chassis sets, connect the TV set to its source of power through an isolation transformer before using this method. END



new DISCS and TAPES

STEREO and MONO

Reviewed by
Chester Santon
Station WQXR
New York City

STEREO recordings, disc and tape, have made very encouraging progress in the short period of 2 years. In the issue of March, 1958, this column carried a description of the first public demonstration of a stereo disc. A bulky and rather primitive stereo pickup was used for playback. At the present time, the stereo disc stands in many instances shoulder to shoulder with the 7.5 four-track open-reel stereo tape; excelling it in some features, trailing behind in others. On my setup, I listen to recent stereo discs when I hanker for subtle highs. I put on a tape when I want maximum separation within the individual range offered by each label.

Basie
Count Basie and His Orchestra
Roulette Stereo Tape (4-track, open-reel) RTC-502 (7-inch; playing time, 32 min. $7.95
***Technical Rating:* GOOD**

The new Basie band sparks a variety of invigorating jazz moods in these Neal Hefti arrangements. Right channel required sharp cutoff at 7,000 cycles in passages containing muted brass. Separation is somewhat exaggerated with Basie piano occupying the left channel in company with the rhythm section. The solidity and spirit of the band hurdle all problems of playback.

Ellington Jazz Party in Stereo
Duke Ellington and His Orchestra
Columbia Stereo Tape (2-track, 7.5 ips) GCB 50 (7-inch; playing time, 22 min. $6.95)
***Technical Rating:* EXCELLENT**

If the last two-track jazz tape you've heard is now a year old, check this reel on a unit equipped with an ultra-narrow-gap playback head. This recording does much to explain Columbia's continued interest in the two-track medium for optimum results on commercial tapes. Duke Ellington's jazz party was attended by several well-known guests. Dizzy Gillespie contributes muted and open horn solos. Jimmy Rushing sings a blues tune. Johnny Hodges' saxophone in *All of Me* is a highlight of the album. Ellington's major contribution to stereo during this particular session is a convoy of nine percussionists stretched out in front of the band. The tune is *Malletoba Spank* and features vibraphones, xylophones, glockenspiel and marimba. Then follows one of the more exciting morsels now on tape. Nine tympani buttress the normal Ellington percussion section. At the present time, only two-track tape can easily handle such an assignment.

It's All Right With Me
Cathy Hayes
Hi Fi Stereo Tape (4-track, open reel) R 416 (7-inch; playing time, 41 min. $7.95)
***Technical Rating:* GOOD**

This reel offers very little in the way of audio challenge since the various instrumental combos accompanying Cathy Hayes are kept in the background. Ace guitarist Barney Kessel arranged this parcel of nightclub tunes with the spotlight on the vocalist. The engineers at the console display more proficiency than does the young lady at the microphone.

Music of Leroy Anderson, Vol. 2
Frederick Fennell conducting Eastman-Rochester Pops Orchestra
Mercury Stereo Tape (4-track, open reel) STB-90043 (7-inch; playing time, 32 min. $6.95)
***Technical Rating:* GOOD**

Playing this reel through a pair of Ultra-Linear amplifiers, I detected some graininess in the response of the high end. Bottom bass didn't have the weight and crispness found in the better two-track reels. Overall listening quality still surpasses that of the average two-track job of several years ago. Excellent separation.

The Virtuoso Organ
Virgil Fox, organist
Capitol Stereo Record SPAR-8499
***Technical Rating:* EXCELLENT**

If you value your audiophile standing, don't rest until you get this one. Capitol now has the most exciting and colorful organ recording I've heard so far on stereo discs. The nine classical works were chosen to demonstrate the tonal resources of the five-manual organ in New York City's Riverside Church. The resident organist, Virgil Fox, skillfully handles the 2½-second reverberation. An exceptional effect in stereo is the echoing interplay of the organ's sections which are separated by a distance equivalent to a city block. A praiseworthy feature of the album booklet is a complete diagram revealing the location of the six microphones used in the recording session.

Hamp's Big Band
Lionel Hampton and His Orchestra
Audio Fidelity Stereo Record AFSD-5913
***Technical Rating:* GOOD**

The audio fur flies high and wide as the high-powered brass section of Hamp's latest band gets the full stereo treatment. Don't look for subtle discipline in the playing of these Hampton originals as trumpets tangle with trombones in the big numbers. This one is loud, fast, and, at times, almost spontaneous.

By Candlelight
Max Jaffa, His Violin and Orchestra
Capitol Stereo Record ST-10220
***Technical Rating:* EXCELLENT**

Capitol's British recording crew takes top honors this month for convincing depth in pop stereo recording. What's more, they do it with a solo violin set against a background of massed strings. It's easy to throw together an illusion of depth by means of artificial reverb, but that was not done in this case. The warmth of strings is preserved through skillful use of enormous studio space. The soft, quiet arrangements of sweet tunes by Gershwin, Rodgers and Hart, Schwartz and Kern flow past with great ease. The solo violin of Max Jaffa injects a rather dry and wiry tone in such a lush acoustical setting, but the unbroken line of orchestral sound is extremely effective between the speakers of a big system.

Sticks and Bones
Marty Gold and His Orchestra
RCA Victor Stereo Record LSP-2070
***Technical Rating:* EXCELLENT**

Flippancy rises to a new estate in these arrangements by Marty Gold. Generous use of trombones and percussion sticks explains the title of the album. The startling clarity of the bells, gong and triangle is more difficult to figure out in view of the response on the average stereo disc. Adequately reproduced, this record indicates that significant improvements are still being made in the reduction of distortion in the range above 10,000 cycles. This is a record to keep in mind the next time you plan to evaluate stereo pickups. The bass response is not bloated and the transients of the uppermost highs provide test material not obtainable on the music bands of stereo test records. The imagination worked into the musical arrangements adds up to a neat bonus under the repeated use which this record most certainly deserves.

Music of the Bedouin Bandits
Fuad Hassan Ensemble
RCA Victor Stereo Record LSP-1991
***Technical Rating:* GOOD**

Ersatz desert stuff that offers more kidding around on the same stretch of sand used by Audio Fidelity some time ago. Although a bit repetitious in some selections, this group is okay for light tongue-in-cheek listening. The *Bolero Ala Drums* episode is ear-catching enough to draw percussion fans from the most distant tribes.

RAVEL: *Daphnis and Chloe (Complete Ballet)*
Pierre Monteux conducting London Symphony Orchestra and Chorus of Royal Opera House, Covent Garden
London Stereo Record CS-6147
***Technical Rating:* EXCELLENT**

No previous version of *Daphnis and Chloe*, stereo or mono, fuses the notes of chorus and orchestra into the type of magic heard here. Monteux directed the first performance back in 1912 and now has the best recording of the batch.

Note: Following record is a 12-inch mono LP and plays back with RIAA curve.

The Science of Sound
Bruce E. Strasser, Writer and Director
Folkways Records FX-6007

Scheduled for release some days after the deadline for this column, this forthcoming two-record set offers a table of contents of primary interest to any student of sound. Produced by Bell Telephone Laboratories, the album covers, among other items, music scales, vibrato and tremolo, the Doppler effect, dissonance, noise measurement, masking, echo and reverberation, delay distortion, pitch, vibration and resonance, how we hear, and intensity.

James Michener's Favorite Music of Hawaii
RCA Victor LPM-2150
***Technical Rating:* GOOD**

A rarity among recent recordings from the islands, this disc traces the development of Hawaiian music. James Michener, the well-known authority on Pacific life, has selected three types of music most frequently encountered in Hawaii—the ancient Polynesian tunes that migrated from Tahiti, the home-grown Hawaiian melodies and the popular songs written by visitors to the islands. The local orchestra and chorus were recorded in Honolulu. Natural charm and a sound totally free of gimmicks place this item at the top of the Hawaiian list. END

Name and address of any manufacturer of records mentioned in this column may be obtained by writing Records, RADIO-ELECTRONICS, *154 West 14th St., New York 11, N. Y.*

ELECTRONICS CONTROLS LEVEL OF MOLTEN GLASS

A lucky break (carefully prepared for in advance) offered the opportunity; electronic knowledge solved the problem

By MURRAY BARLOWE *

MANY people have asked me how I, a radio–TV service shop operator, got into industrial electronics servicing. I usually tell them, "It's like getting into anything else—if you want to badly enough, and think about it enough, and plan and prepare long enough, you'll find a break that will make it possible. That's the way it happened to me."

Some time ago I was called by a Mrs. Yahnkers who told me her husband had been having difficulty with their television set. She asked me to come over at lunch time to meet him so he could show me just what the set was doing wrong. I knew that Mr. Yahnkers was the plant manager at the local glass factory, so I made a date with him for the next day.

It turned out that the switch contacts on his tuner were causing intermittents on several channels. I explained it to him, got his OK on a replacement and took the set to the shop.

When I returned it he was there to check it out and, as I learned, to check me out too. I'd been talking up repairing electronics other than home entertainment devices to all my customers, and apparently something I'd said or maybe the way I'd repaired his TV set, had impressed Mr. Yahnkers. Whatever the reason, he asked me if I'd take at look at a problem at his plant, a local manufacturing branch of the Pittsburgh Plate Glass Co., in Hicksville, N. Y.

They were having trouble maintaining the level of molten glass in their furnaces. I suggested that it might be solved electronically. Mr. Yahnkers was interested and told me to see what I could come up with.

The process of manufacturing fiber glass consists of drawing glass fibers from a melting furnace and winding them on a rapidly rotating drum. Broken glass is dropped into the furnace through an opening in the top, and glass fibers are drawn through openings in a bushing plate on the bottom. Variations in the level of molten glass affect its temperature, thus varying its viscosity. This in turn varies the diameter and causes the drawn glass fibers to break.

The feeding of glass from the hopper was electrically controlled. A circuit was closed at regular timed intervals, dropping a predetermined amount of glass into the furnace. The level of the glass was monitored visually by operators checking 48 furnaces! As the level changed, the rate of feed was adjusted by changing the timer interval. Obviously, what was needed was a sensing device to check the glass level. It would complete an automatic control loop and eliminate the need for manual monitoring.

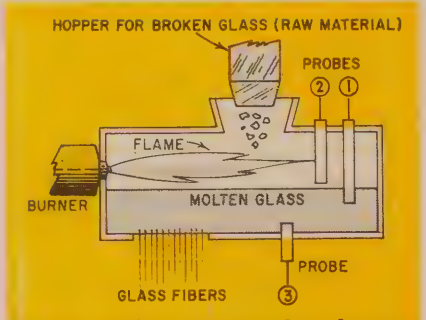


Fig. 1—Probe setup in glass furnace.

First steps

I found out that molten glass is a conductor. So we put a pair of high-temperature metal probes into the furnace, one through the bottom into the glass, the other through the top with its tip set at the desired level. These probes are about the size of long pencils, and are used purely to make electrical contact with the molten glass. The resistance of the glass was measured and a simple control unit attached. This worked for a day, and then became erratic. Investigation showed that, not only was the glass conductive at this high temperature, but so was the burning gas above it. I noticed that the resistance of the gas was higher than the glass so I added a sensitivity control to the unit in an attempt to differentiate between glass and gas resistance. Operation was improved but was still not dependable. The resistance of gas and glass varied so that it was impossible to find a stable setting for the sensitivity control. Further investigation revealed that, even though the resistance of the gas and glass varied all over the lot, the ratio of their resistances was always at least 3 to 1.

This was something that you could hang your hat on. So the next step was to develop a circuit that could sense this 3-to-1 relationship. By using a three-probe arrangement (Fig. 1), I was able to compare the resistance between probe 1 and 3 to the resistance between 2 and 3. Probe 1 is always in the glass and senses glass resistance at all times. Probe 2 is in gas or glass,

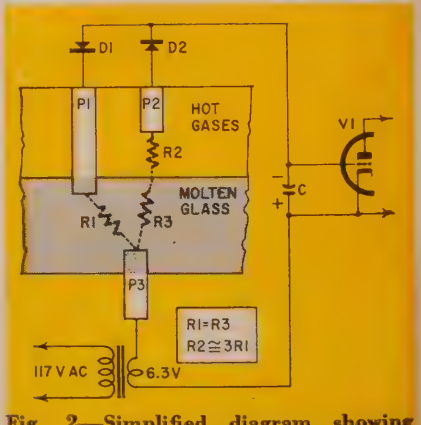


Fig. 2—Simplified diagram showing probe arrangement and how it works.

* Barlowe TV, Bethpage, N. Y.

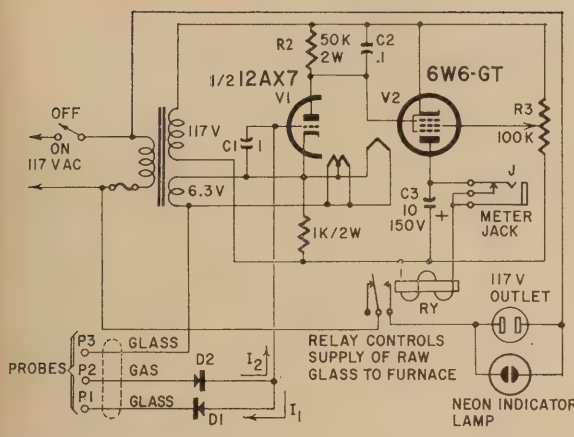


Fig 3—Circuit of complete level-detector unit, less probes

depending on the glass level. The ratio of resistance between 1 and 3 and 2 and 3 indicates positively whether probe 2 is in gas or glass. A small rectified ac voltage is passed through these probe circuits by D1 and D2 (Fig. 2), and the resultant control voltage is applied to the grid of a vacuum tube.

Resistances R1 and R2 represent the resistance of the glass or the gas. When the level is high, both probes are in the glass, the resistances are equal. The currents from the ac source through the diodes are equal and in opposite directions. When the level drops, probe 2 is in gas, resistance goes up at least three times and current through D1 is three times as great as through D2. Capacitor C charges in the polarity indicated and the tube is cut off, causing a relay to close which allows a supply of raw broken glass to drop into a hopper which feeds the charge to the to the furnace.

We built a prototype unit on this principle and tested it. It operated so well that Pittsburgh flew in a patent attorney from their home office to evaluate the device. This resulted in US Patent No. 2,868,396, filed March 12, 1956, and granted Jan. 13, 1959. We subsequently manufactured 60 of these automatic control units (48 installed on the furnaces and 12 standby units). We also did the actual wiring and installation of the units.

How it works

Looking at Fig. 3, here's how the unit works:

P1 is the reference probe which always remains in the molten glass. A fixed amount of current flows from the filament transformer through P3 and the glass to P1, through D1, charging capacitor C1 a few volts negative. This is enough to bias V1 beyond cutoff.

If the glass level reaches P2 (gas probe), it eliminates the resistance of the gas. An equal amount of current now flows through both diodes, but in opposite directions. This current flow charges C1 to an equal potential in the opposite direction, exactly cancelling out the initial negative voltage. This removes the cutoff bias from V1 making it conduct heavily. If the glass level drops, the resistance of the gas is added in series with the resistance of the glass, cutting down the amount of current through diode D2. I_1 is now greater than I_2, charging C1 and biasing V1 beyond cutoff.

If V1 is biased beyond cutoff, its plate voltage goes up. This positive voltage is direct-coupled to V2's grid, increasing its plate current which energizes the relay and closes the circuit to the output socket. This makes glass feed into the hopper. As soon as the glass gets up to the proper level, equal currents zero the voltage across C1, V1 conducts, its plate voltage drops, bias on V2 goes strongly negative (almost to cutoff). The relay then opens, cutting off the feed of raw glass to the hopper that supplies the furnace.

Note that there is no dc power supply—it isn't needed. Raw ac is applied to the tubes, which conduct on each half cycle. Capacitor C2 filters the pulsating dc developed across R2, and C3 filters the voltage across the relay coil, eliminating relay chatter.

R3 sets V2's operating point. J is a metering jack which is normally closed. It is used to measure the relay current when setting R3. The neon indicator lamp shows when the control is calling for glass.

A test set simulates the conditions in the furnace for setting units up in the shop and checking them out without having to use an operating furnace.

The test set consists of three resistors, which simulate the resistances of the gas and the glass, and a switch, which simulates raising or lowering of the glass level to contact probe P2. END

HOW LEAK DETECTORS WORK

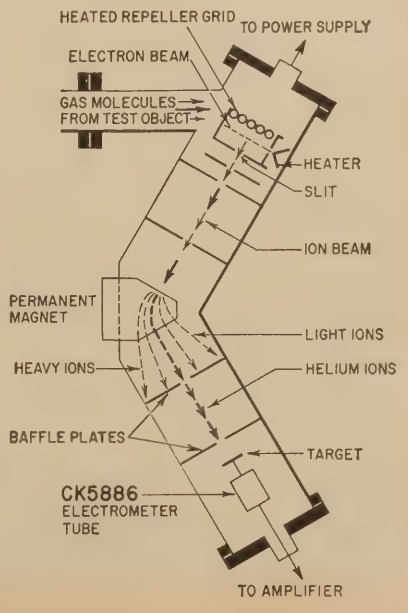
LEAK detectors are extremely sensitive instruments which locate and indicate the size of very small leaks by measuring the rate of flow of a rare gas, usually helium, through the leaks. The sensing element is a mass spectrometer tube which responds to the presence of minute quantities of helium, providing an electrical signal proportional to the amount of the gas present. Leak detectors are used for production testing of practically anything which must be hermetically sealed when it is in use.

The object to be leak-tested is exhausted to a high vacuum, then sprayed with helium while its empty insides are connected to the leak detector. Another method requires that the object be filled with helium under pressure, and the leak detector then searches the surface of the object.

The mass spectrometer tube detects the presence of helium in microscopic quantities by connecting to the vacuum system so that the tube is in series with the test object and the vacuum pumping system. As gas molecules enter the spectrometer tube, they are bombarded (Fig. 1) by electrons emitted from the hot heater. When a bombarding electron strikes a molecule, an electron is knocked off the molecule, leaving it positively charged, or ionized. These positive ions are pushed out of the chamber, or "ion gun," by an ion repeller grid.

Other electrodes appropriately charged direct the ions into a beam, which is passed between the poles of an external permanent magnet. The magnetic field deflects each ion, the lighter ions being deflected more than the heavier ones. The spectrometer tube is tuned so that the helium ions are the only ones deflected through exactly the correct angle to hit the target. All other ions are stopped by the baffle plates.

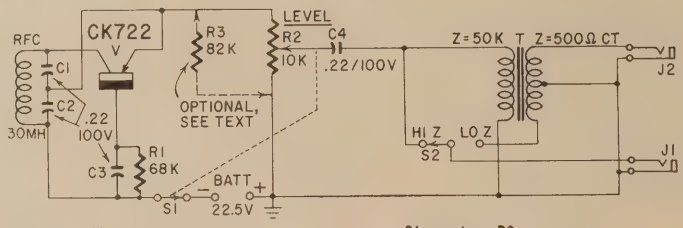
The flow of helium ions to the target constitutes a small electrical current which is amplified by an electrometer tube and then built up by a very stable amplifier which drives a meter or produces an audio tone. Since only the helium ions reach the collector, spurious signals from other ions are therefore eliminated. END



AUDIO GENERATOR for Industrial Service Jobs

For field-service work, the industrial technician needs a portable audio generator. Here is a fixed-tone 1-transistor unit that is hard to beat

By WILLIAM F. KERNIN



R1—68,000 ohms, ½ watt
R2—pot, 10,000 ohms, linear taper, with spst switch
R3—see text (optional)
C1, 2, 3, 4—0.22 μf, 100 volts, paper
BATT—22.5 volts (Burgess U-15, Mallory RM-412R or equivalent)
J1, 2—phone jacks
RFC—30 mh (Miller 692 or equivalent)
S1—spst on R2
S2—spdt toggle
T—output transformer: primary 50,000 ohms: secondary, 500 ohms ct (UTC H-1 or equivalent)
V—CK722
Case—4 x 4 x 2 inches
Miscellaneous hardware

A PIECE of test gear is usually designed to fit the type of equipment to be serviced and the conditions that may be encountered on location. This seems especially true in industrial electronics. One example is a field-service audio oscillator designed for the industrial electronics technician.

It is a single-frequency instrument with a variable-amplitude output. Completely self-contained, the one-transistor unit does not require external power connections.

In setting up and adjusting industrial motion-picture sound-recording equipment, a 3,000-cycle tone is often recommended. Also, 3,000 cycles falls within the band of frequencies to which the average ear is most sensitive—particularly at low amplitude. So the oscillator is designed for a 3,000-cycle output. This becomes very valuable when servicing equipment in locations with a high background-noise level. Typical examples include production areas, computer rooms and dispatch and control areas.

Stability is another design factor. Not so much frequency stability, but rather the ability to provide a clean sine wave into a wide variety of loads.

Finally, for economy and ease of repair, the test oscillator has to be simple and built from the same types of components used in companion pieces of test gear, if possible.

Circuit details

The diagram shows the circuit. A Colpitts oscillator proved more stable under adverse loading conditions than other forms of transistor audio oscillator circuits tried. The output remains a clean 3,000-cycle sine wave with 2% total measurable distortion for loads down to 5 ohms.

A CK722 was used with a 22.5-volt supply to conform with parts used in companion equipment. The tank circuit —C1, C2, and RFC—determines the operating frequency and supplies the necessary feedback to sustain oscillations. Resistor R1 provides the proper operating bias on the transistor. Potentiometer R2 acts as the emitter load in addition to controlling output amplitude. Capacitor C4 and transformer T match the oscillator's output to a variety of loads.

A pair of phone jacks (J1 and J2) and switch S2 provide three types of output.

With S2 in the LO Z position, J1 and J2 provide a 500-ohm balanced line output. These jacks are mounted to match the duplex phone plug used for patch cords in broadcast and communications work. If a low-impedance, single-ended output is desired, one jack is used with ground. Such an output can be used for loads down to 5 ohms.

With S2 in the HI Z position, J1 is across T1's high-impedance primary. This provides maximum output into high-impedance loads ranging from 1,000 ohms up.

Output for the HI Z position can be set for a maximum of 1 volt rms into a 50,000-ohm load. This corresponds to a 100-mv output from the balanced-line jacks into a 500-ohm load with S2 in the LO Z position. As the loading increases, output voltage drops. However, the output will remain a pure sine wave with 2% overall distortion down to a 5-ohm load.

The maximum output voltage is determined primarily by the value of the bias resistor (R1) and, to a lesser degree, by R2. The values shown produce a maximum HI Z output of approximately 0.9 volt—90 mv for the LO Z balanced output. Resultant total current drain on the battery—1.8 ma. For the full 1-volt output, insert resistor R3 and adjust about the typical value shown to obtain the exact voltage, if desired.

A 4 x 4 x 2-inch black crackle utility box forms the basic package for the unit. Physical parts layout can be seen from the photographs. A Burgess U-15 battery—22.5 volts—is the power source.

Wiring and parts placement are not critical. The transistor is soldered into the circuit for ruggedness. A proper heat sink on the leads should be used when soldering the transistor into the circuit. This prevents damaging the unit with excessive heat. Finally, correct battery polarity must be observed.

Put it to work

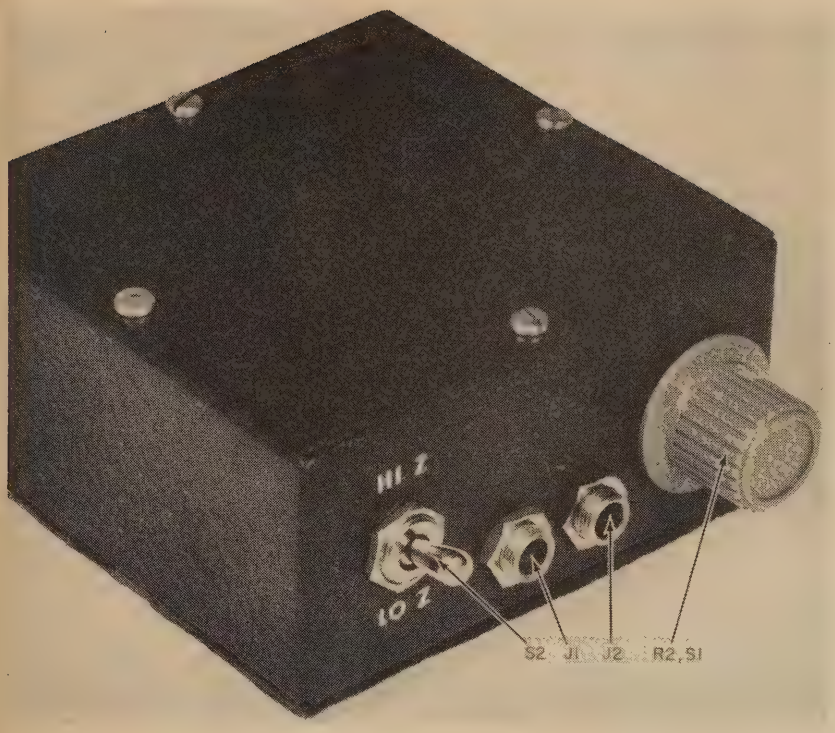
As an audio source for normal signal tracing, the transistor audio oscillator serves quite well. Requiring no external power, it is ideal for checking remote microphone and communications lines. An audio signal is fed into the line using either the HI Z or balanced 500-ohm output—depending on the characteristics of the line. This signal can be readily checked at the other end with a pair of headphones or the existing audio equipment.

A variation of this procedure can be used to check and identify multiconductor lines such as those used in intercom and multiplex control systems.

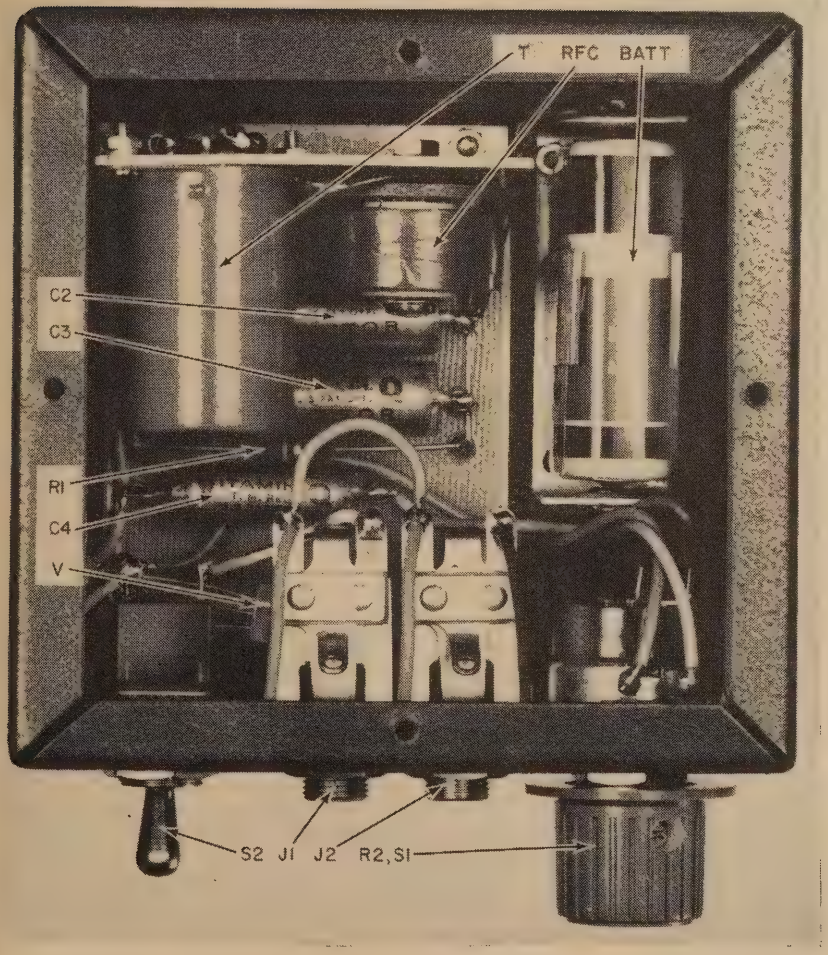
The unit lends itself to servicing professional audio and tape recording equipment. Since its output is a clean 3,000-cycle sine wave, it is heard as a pure tone through appropriate reproducing equipment. To check tape recording gear, record the 3,000-cycle signal on the tape at a suitable level. When played back, it should still be a pure 3,000-cycle tone.

Any irregularities can be quickly detected by ear. Things such as sticky or dirty heads, variations in motor speed, roughness and irregularities in a tape flywheel drum, incorrect head positioning and other mechanical defects show up as variations in the reproduced tone. To check the reproduce electronics or system alone, use a prerecorded tape of the 3,000-cycle tone. This procedure also applies to checking audio gear for excessive distortion and overload.

These are a few of the many jobs the transistor audio oscillator can do and do well. It was designed for a specific type of service but is readily adaptable to many other tasks. END



Completed unit in its 4 x 4 x 2-inch case.



All components are solidly mounted to avoid damage from rough handling.

NEXT MONTH

All-Transistor FM Receiver

Circuit analysis of a popular imported transistor FM portable. A working knowledge of its circuits will stand you in good stead when domestic models hit the market.

Servicing Horizontal Sweep Circuits

Too many technicians short-change themselves by not making systematic and exhaustive tests when troubleshooting sweep circuits. Follow the author's step-by-step guide to quicker sweep-circuit repairs.

Transistorized Photoflash

Constant light output, long battery life, fast recycling and light weight are but a few of the features of this electronic photoflash unit. Ordinary flashlight cells deliver about 80 flashes.

VTVM Switches to Powerless Voltmeter with Simple Conversion

A vtvm is useless away from ac power lines. A switch and a couple of resistors will convert it to a full-range dc voltmeter useful for servicing when power is not available.

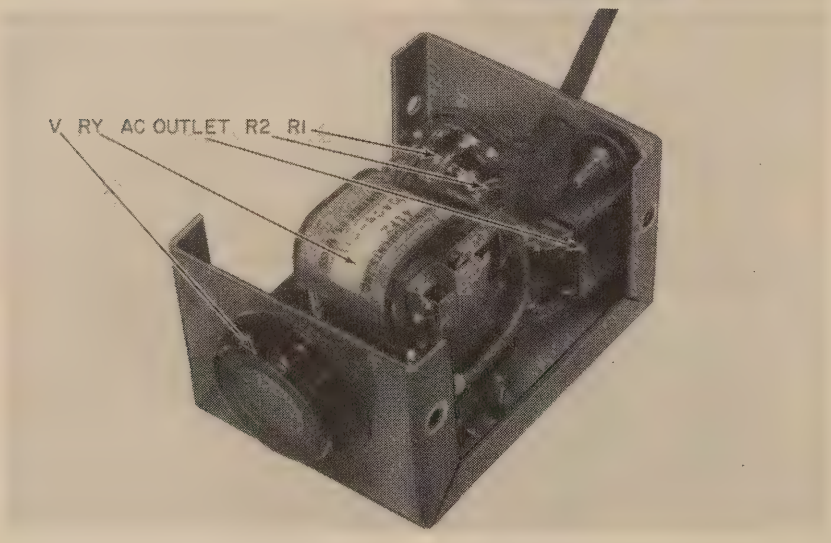
Putting Audio Transformers to Work

Audio transformers are much more complex than they seem and their performance can be tricky in some circuits. A well-known authority explains how to use them and modify their response to meet your needs.

PHOTOELECTRIC CONTROL MADE EASY

It takes only five components and a case to build what is one of the simplest photoelectric controls

By R. L. WINKLEPLECK



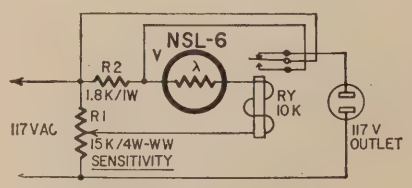
(Top right) Completed light control. Sensitivity control and ac outlet for controlled device are on front panel.

(Above) Two resistors, photocell and relay are vital parts of the light control.

THE many very real needs for control devices which respond to variations in light intensity have resulted in a number of commercial control units and many designs for home construction. Applications seem almost without limit and more are being found every day. There are automatic door openers, street-light controls, home and industrial controls for automatically turning on lights in the evening, liquid-level indicators, industrial counters, safety interlocks, burglar alarms, etc.

Convenient as such devices are, even around the home, they're not inexpensive since most of them depend on an amplifying system which builds up the comparatively weak signal of the light-sensing tube or cell to a level great enough to actuate a relay. But this cost picture has changed with the appearance of a photoconductive cell which combines good sensitivity with improved power-handling ability and low price. It is now possible to build a light-actuated control in which the photocell *directly* drives a moderately sensitive relay, and doesn't require direct sunlight to do so. Thus, a power source, a relay and the new photocell make up the complete control.

The diagram and photos show a control unit specifically designed to turn on lights automatically and unattended as nighttime approaches. It has only four major components. Wirewound potentiometer R1 is a voltage divider that acts as a sensitivity control. Cadmium sulphide photoconductive cell V is a light-sensitive resistor whose resistance varies inversely with light intensity. It is hermetically sealed in a 1¼-inch diameter metal disk with a 0.62-inch window. It has a 1-watt power dissipation rating. The cell used is a National Semiconductors type NSL-6 available in this country through Harvey Radio, 103 W. 43rd St., New York 36, N. Y. Price $2.45.



RI—pot, 15,000 ohms, 4 watts, wirewound
R2—1,800 ohms, 1 watt
RY—spdt relay, 10,000 ohms (Sigma 41-FZ-10000-ACS-SIL or equivalent)
V—photoconductive cell (NSL-6, see text)
117-volt outlet
Case, 2¾ x 2⅛ x 1⅝ inches
Miscellaneous hardware

Circuit of the uncomplicated device.

The relay is a fairly sensitive ac unit. Resistor R2 isn't absolutely essential, but does contribute to smooth operation for an application where light intensity varies slowly. Frequently, under such conditions, there is a tendency for relay chatter at the point where it is just ready to pull in or drop out. In this circuit, the relay shunts R2 on pull in and restores it to the circuit on release. This effectively swings total circuit resistance rapidly across the critical point and minimizes relay chatter.

Construction is obviously simple. All components are easily assembled in a 2¾ x 2⅛ x 1⅝-inch case. Leads are short and their placement is noncritical. It's a very short one-evening project.

Warning: *do not make any connections to the unit's case or you will have a hot-chassis hazard in the making. As an added precaution, it might be wise to place the unit in some out-of-the-way spot when it is in use.*

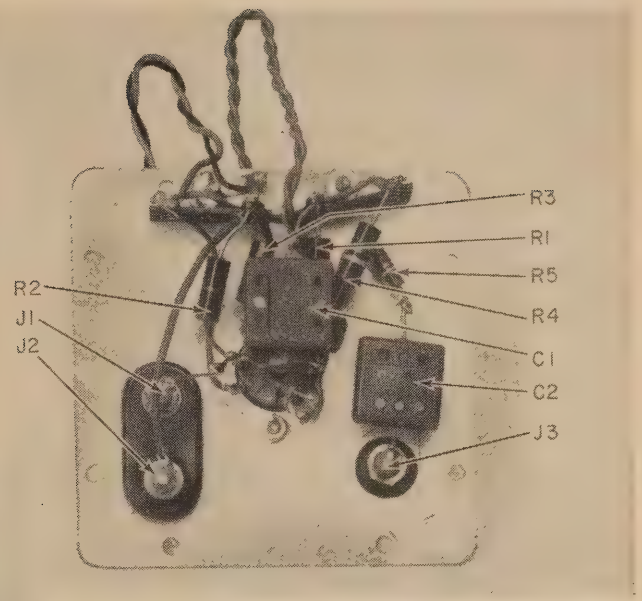
In use, the unit is plugged into a convenient outlet and placed close to a window. A lamp is plugged into the outlet on the unit. The SENSITIVITY control is adjusted so the lamp goes on when outside light fades to the desired level. The only precaution is to be sure the light from the lamp does not strike, directly or by reflection, the sensitive area of the photocell. A black cardboard tube over the cell might be helpful. For outside use, it can be pointed at northern sky and a small shelter rigged up to protect it both from weather and any interfering lights.

Only slight modifications are necessary to adapt this basic unit to other applications. If it's to be used to open garage doors when illuminated by the auto headlights, R2 may be omitted and the door operator connected to the normally open contacts on the relay so the operator is actuated when light strikes the photocell. Protect the light cell from daylight with a long black tube aimed so the cell is directly illuminated by the auto headlights as the car approaches the garage.

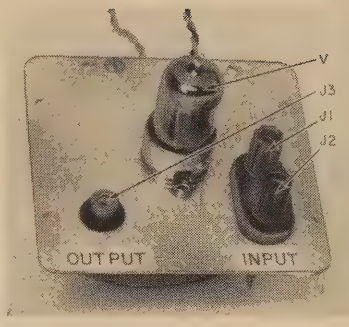
This unit has an advantage in addition to sensitivity, simplicity, dependability and construction economy: it doesn't cost much to operate. Many applications require such a control to be in constant operation. This unit uses less than 1 watt in darkness and less than 2 watts when illuminated. END

UNIVERSAL 2-TERMINAL OSCILLATOR

Connect a resonant circuit across the two input terminals and the output frequency is the test circuit's resonant frequency



Under the chassis are the few resistors and capacitors that form the guts of the 2-terminal oscillator.



On top of the chassis only the tube and output and input terminals show.

By PAUL S. LEDERER

WHILE experimenting with circuits involving a number of parallel-resonant networks, I needed a quick and convenient way of locating the resonant frequency or for tuning the network to resonate at a desired frequency.

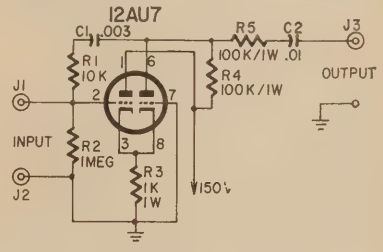
The circuit that developed is a two-terminal oscillator that consists of a cathode-follower direct-coupled to a grounded-grid voltage amplifier. Part of the signal at the grounded-grid amplifier's plate is fed back to the cathode-follower's grid through a resistor and blocking capacitor. This positive feedback makes the circuit operate as a multivibrator as long as there is no resonant circuit across the input terminals. When a resonant circuit is connected, the system oscillates at the parallel-resonant frequency.

Experiments indicate that the oscillator works best when the inductances are between 1 and 100 mh. Inductances tested included if transformers, toroidal coils and pie-wound rf chokes. Tuning capacitances were varied over a wide range and showed that the oscillator works well up to about 500 kc.

A series of tests were made using various combinations of inductances and capacitances and comparing the resonant frequencies obtained with the two-terminal oscillators and those obtained by feeding the tuned circuit from a constant-current audio oscillator and noting the oscillator frequency that gave maximum voltage across the tuned circuit. Variations did not exceed 3% except when self-resonant frequencies were measured. In these cases, frequency variations up to 10% are probably caused by variations in the capacitance of leads and instruments.

Tests to determine self-resonant frequencies of rf chokes with no external tuning capacitance across the choke indicated that the oscillator circuit presents a capacitance of about 30 $\mu\mu$f across the input terminals. This tends to make a self-resonant frequency measured in this manner a little lower than the correct one.

While it was not possible to find minimum Q values required for satisfactory operation, it appeared that the circuit would function properly as long as the *parallel impedance of the tuned circuit exceeded 300 ohms.* Thus, for example, a 1-mh pie-wound rf choke in parallel with a .01-μf capacitor (about 320 ohms parallel impedance) makes a 51-kc oscillator frequency (the computed value). Raising the capacitance to .02 μf (parallel impedance about 220 ohms) stops oscillations.



R1—10,000 ohms, ½ watt
R2—1 megohm, ½ watt
R3—1,000 ohms, 1 watt
R4, 5—100,000 ohms, 1 watt
C1—.003 μf, mica
C2—.01 μf, mica
J1, J2—dual 5-way binding posts
J3—pin jack
V—12AU7
Socket, 9-pin miniature
Chassis
Miscellaneous hardware

Circuit of the 1-tube unit.

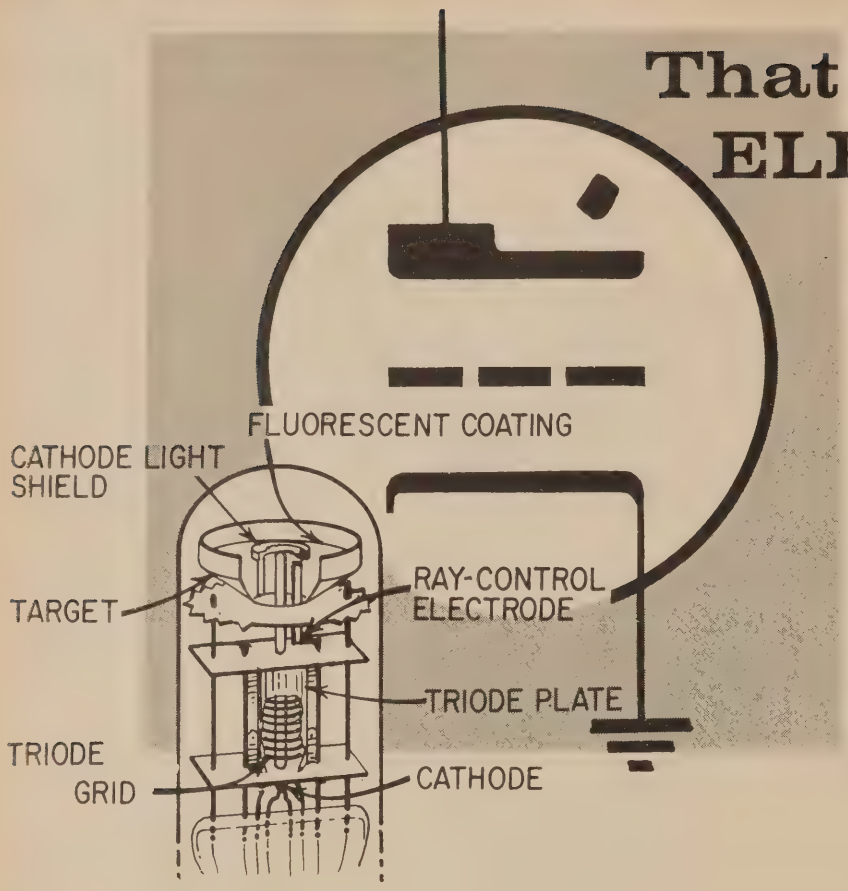
Similarly, a 100-mh precision inductor shunted by 0.32 μf (parallel impedance about 500 ohms) produces oscillations at 890 cycles. Raising the capacitance to 2.0 μf (parallel impedance about 200 ohms) stops oscillations.

A 12AU7 double triode is used in the oscillator circuit. About 6 ma at 150 volts is required for the plate supply. The output voltage delivered by the circuit through a 100,000-ohm resistor and .01-μf capacitor (to reduce loading of the circuit) ranges from about 25 volts rms at the low frequencies to about 0.5 rms near 500 kc. It varies somewhat with the type of inductance used, but is generally high enough for oscilloscope display (Lissajous patterns for frequency determination) or in industrial or research use, for feeding direct reading electronic counters. END

BENCH TESTED

Tests conducted by a member of the staff of RADIO-ELECTRONICS show that the oscillator operates substantially as the author indicates. However, it is useful up into the lower megacycle range and is not limited to 500 kc. Accuracy, as checked with a scope, is better than 3%. Parallel impedance of tuned circuit must be more than 300 ohms for the circuit to operate properly. Without any external components connected to the input terminals, the circuit becomes a free-running oscillator.

That Versatile ELECTRON-RAY TUBE



Some interesting and useful test instruments can be built around it. Four such devices are described here—a volt-ohmmeter; picture-tube circuit tester; grid-dip meter, and a capacitor tester

By JOHN POTTER SHIELDS

THE electron ray tube, more popularly known as a "magic eye tube," was developed in the mid '30's for use as a visual tuning indicator in radio receivers. Construction of such a tube is shown above.

The most common type of electron-ray tube has two sections. The first, a triode, operates as a dc amplifier and the second is the actual electron-ray indicator. In operation, the heated cathode emits electrons which are attracted by the positively charged target of the electron-ray section. This target is

Fig. 1—Basic indicator circuit using a 6E5.

coated with a phosphor which fluoresces when struck by a stream of electrons.

An element known as a ray-control electrode is mounted between the cathode and target. When this electrode is more negative than the target, electrons headed toward the target space behind the ray-control electrode are repelled. This causes that portion of the target to remain unlit, casting a shadow. As the ray-control electrode becomes less negative, the shadow angle decreases.

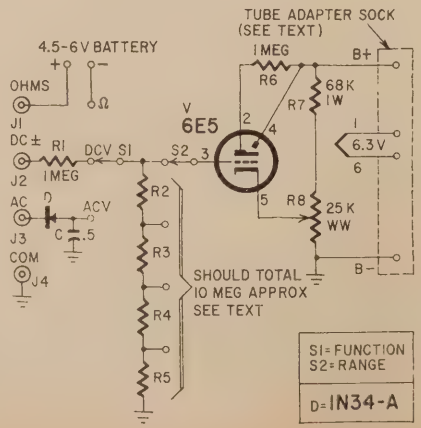
The voltage applied to the ray-control electrode is proportional to the voltage at the triode section's grid. The triode plate current through load resistor R (Fig. 1) produces a voltage drop which determines the voltage applied to the ray-control electrode, since it is directly coupled to the triode plate. Therefore, increasing the negative voltage at the triode's grid causes a corresponding decrease in target shadow angle and vice versa.

This description applies to 6E5 and 6U5 tubes. The 6E5 contains a sharp-cutoff triode while the 6U5 contains a remote-cutoff one. The 6AF6 operates on a similar principle, but contains two independent ray-control electrodes and no triode control section. (There is also a type 6AL7 electron-ray tube which was designed for use as a tuning indicator in FM receivers.)

Now that we have seen how this tube works, let's see what we can use it for besides a tuning indicator.

Volt-ohmmeter

The multimeter circuit of Fig. 2 uses an inexpensive 6E5 to take the place of a sensitive meter movement. It measures positive or negative dc voltages, ac voltages and resistance. It has the standard high input impedance of a true vtvm and four voltage and resistance ranges. Resistor values for the string can be calculated to suit, or picked up from any article on making



R1—1 megohm
R2, 3, 4, 5—select to give desired ranges (total resistance should be approximately 10 megohms)
R6—1 megohm
R7—68,000 ohms, 1 watt
R8—pot, 25,000 ohms, wirewound
All resistors ½-watt 10% unless noted
C—0.5 μf, 600 volts
D—1N34-A
J1, 2, 3, 4—pin or tip jacks
S1—single-pole 3-position rotary
S2—single-pole 4-position rotary
V—6E5
Battery, 6 volts
Socket, 6-pin for V
Test adapter socket (see text)
Chassis to suit
Miscellaneous hardware

Fig. 2—A 6E5 takes the place of sensitive meter in this vom circuit. Unit has the same high impedance as a vtvm.

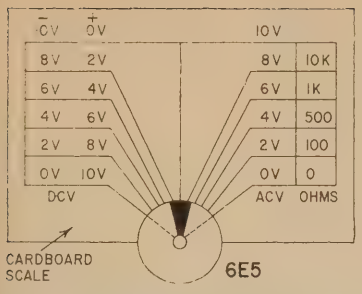


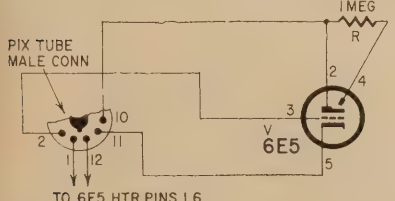
Fig. 3—Dial scale used with the electron-ray vom.

a vtvm. Because of its extremely high input impedance, it will not load the circuit under test. This is especially valuable when measuring oscillator grid and avc voltages. The standard multimeter, with its rather low input impedance, may draw excessive current from such a circuit, causing it to function improperly and giving false reading. This little meter is rugged and compact and practically burnout-proof. There is no delicate meter movement to be damaged.

Another unusual feature of the meter is its power supply. All operating voltages are derived from the device under test. A tube adapter socket is used to tap off operating voltages. Since almost all radios, amplifiers and TV sets use a power-amplifier pentode somewhere in the circuit, you only have to remove this tube, insert the adapter and reinsert the tube in the top of the adapter. The tube must be inserted in the adapter or operating voltages in the device being tested may be upset. A miniature adapter can be used if desired or a small power supply can be built into the meter.

The meter scale (Fig. 3) is self-explanatory. Calibration is simple, requiring only a variable ac and dc voltage supply and a calibrated meter. The ohms scale is calibrated, using a decade resistance box and a small battery.

An unusual trick is used in the meter. A tuning eye gives a shadow-angle decrease only with a corresponding increase in *negative* grid-to-cathode potential and normally would be useless for measuring positive input voltages. This problem is solved by connecting a potentiometer between B-plus and ground. The cathode of the 6E5 is connected to the movable arm of the pot. Thus, the pot can be adjusted to make the cathode more positive than the grid, which is the same as making the grid negative with respect to the cathode. The arm of the pot is adjusted so that the 6E5 shadow *just closes*. Now, a positive potential applied to the input of the meter *increases* the shadow angle from zero with an increase in *positive* input voltage. Since the positive voltage required for a given increase in shadow angle is identical with a given negative voltage for the same decrease, no separate calibration is required for positive and negative scales. The crystal diode in the ac circuit must be polarized to provide a negative output.



R—1 megohm
V—6E5
Socket, 6-pin for V
Male picture-tube connector
Chassis to suit
Miscellaneous hardware

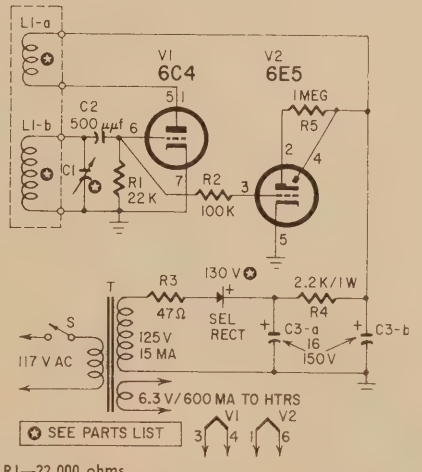
Fig. 4—A few easy-to-get parts go together to form a picture-tube circuit tester.

Picture-tube circuit checker

Fig. 4 shows another very handy little tester. This unit helps check the operation of a TV receiver. The CRT socket is removed from the set's picture tube and plugged into our gadget. If heater voltage is being applied the 6E5's heater will light. If first anode voltage is reaching the picture tube, the 6E5 will show its familiar greenish target glow. If video information is reaching the cathode or grid of the picture tube (as the case may be), the 6E5 shadow will have a hazy, fluctuating appearance. This gadget is easy to build and its use can save the service technician a lot of time and trouble.

Grid-dip meter

Fig. 5 shows our electron-ray tube used in a grid-dip meter. Here the electron-ray tube, a 6E5, takes the place of a 0–1-ma meter. The 6E5 is inexpensive and much more rugged than the meter movement. A tickler feedback circuit employing four-prong plug-in coils is used. The 6E5 grid is connected through an isolating resistor to the grid of the 6C4 oscillator. When the grid-dip oscillator (gdo) is tuned to resonance with an external circuit, the 6C4 grid voltage drops, causing a drop in the 6E5's negative grid voltage. This, in turn, decreases the 6E5's shadow angle. In using this or any other gdo, do not couple it too near the circuit under test. Too close coupling broadens the eye-shadow dip, giving less accurate readings.

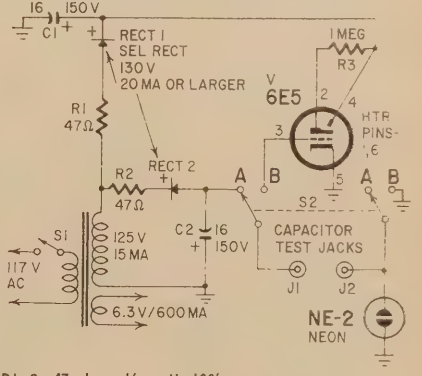


R1—22,000 ohms
R2—100,000 ohms
R3—47 ohms
R4—2,200 ohms, 1 watt
R5—1 megohm
All resistors ½-watt 10% unless noted
C1—variable capacitor, value to match plug-in coils
C2—500 μμf
C3—16-16μf, 150 volts, electrolytic
L1—set of plug-in coils to give desired frequency range
RECT—selenium, 130 volts, 20 ma
S—spst toggle
T—power transformer: primary 117 volts; secondary, 125 volts, 15 ma; 6.3 volts, 600 ma (Stancor PS-8415 or equivalent)
V1—6C4
V2—6E5
Socket, 6-pin for V2
Socket, 4-pin for L
Chassis to suit
Miscellaneous hardware

Fig. 5—A grid-dip meter is another instrument in which an electron-ray tube can be used.

Checking capacitors

A capacitor checker is another use for the 6E5. The circuit in Fig. 6 is such a device. When switch S2 is in position A, the capacitor under test is charged by the dc power supply. If the capacitor is shorted or very leaky, the neon lamp in series with it lights. If the capacitor is intermittent, the neon lamp flashes erratically. When switch S2 is thrown to position B and if the capacitor is OK, the 6E5 shadow first closes completely and then gradually opens to its normal angle. If the capacitor is open, the shadow angle remains unchanged. The time it takes the shadow angle to return to normal after it has closed depends mainly upon the capacitance of the capacitor being tested. However, by familiarizing oneself with the action of this device with known good capacitors, one can make a good check of the quality of a suspected unit. For a given value of capacitance, the time it takes the shadow angle to return to normal will be longer with a higher quality capacitor—less leakage. END



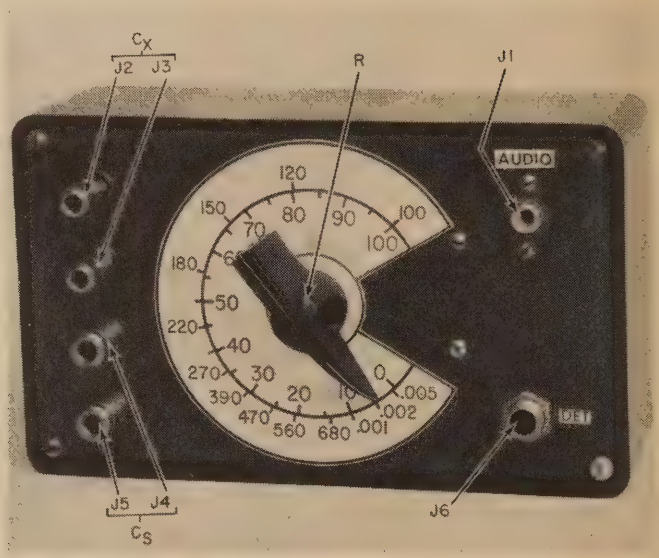
R1, 2—47 ohms, ½ watt, 10%
R3—1 megohm, ½ watt, 10%
C1, 2—16 μf, 150 volts, electrolytics
J1, 2—pin or tip jacks
RECT 1, 2—selenium, 130 volts, 20 ma or larger
S1—spst toggle
S2—dpdt toggle
T—power transformer: primary 117 volts; secondary, 125 volts, 15 ma; 6.3 volts, 600 ma (Stancor PS-8415 or equivalent)
V—6E5
Socket, 6-pin for V
Neon lamp, NE-2
Chassis to suit
Miscellaneous hardware

Fig. 6—This simple capacitor checker can be built in an evening.

mini-capacitance TEST SET

Handy instrument measures capacitances between 1 and 5,000 μμf

By DAVID STONE



ANY electronic experimenter or technician will find lots of use for this instrument. It is specially designed for capacitances from about 5,000 μμf down to 1 μμf or less. Thus it can measure short transmission lines, interelectrode capacitance, unknown micas and ceramics, etc. Another important application: use it to set variables and trimmers to required values. Easy to assemble and operate, when accurately calibrated, it is capable of very high precision.

The basic circuit (Fig. 1) consists of a transformer, standard capacitor and calibrated potentiometer. An external audio generator feeds the primary of transformer T. It also sends current through capacitor C_x, the unknown. The transformer's secondary feeds capacitor C_s through a voltage-dividing network. Note that the windings must be connected out of phase, so detector currents will oppose.

The current through the unknown is $E_1 \times C_x$ (if we ignore detector impedance). Through C_s it is $E_2 \times C_s$. When these are equal (and opposite), no sound is heard or measured at the detector jack. Therefore at balance $\frac{E_1}{E_2} = \frac{C_s}{C_x}$. Since C_s is known, it is easy to calculate C_x if the voltage ratio is known. Thus, R1 can be calibrated in terms of voltage ratio. Then, at null, it is easy to calculate C_s from the dial setting. Still better, R1 may be calibrated directly in terms of C_x for any given C_s. This is the method used here and it will be described.

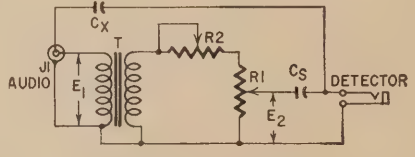
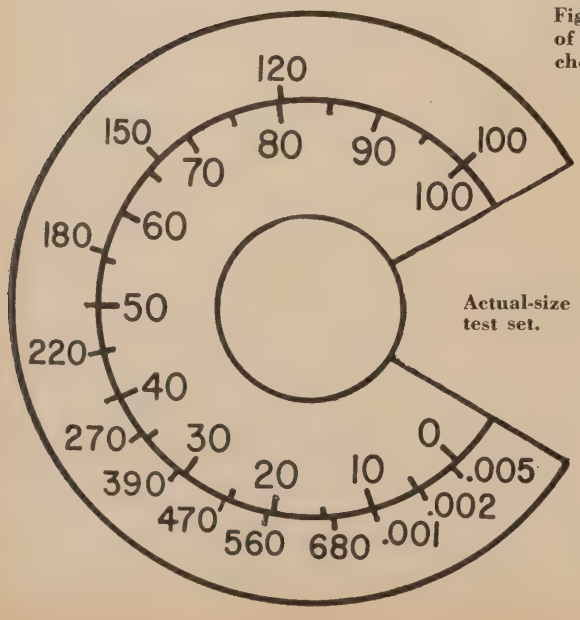


Fig. 1—Basic circuit of the mini-capacitance checker.

Fig. 2 is a more practical form of the instrument. All components are mounted on a bakelite panel made for a box measuring 6 x 3¾ x 2 inches. Transformer T is a subminiature transistor unit available from Lafayette Radio (Argonne AR-113). Any other similar transformer would also work well. For example, an interstage transformer with a 500-ohm primary and a 5,000-ohm center-tapped secondary is

(*Continued on page 70*)



Actual-size dial for the test set.

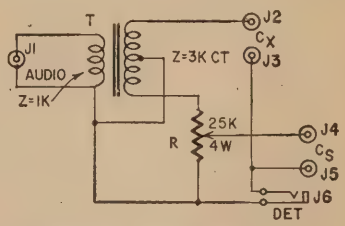


Fig. 2—Complete circuit of the test set.

R—25,000 ohms, 4 watts, linear taper
T—see text
J1—phono jack
J6—phone jack
J2, 3, 4, 5—binding posts
Bakelite box 6 x 3¾ x 2 inches

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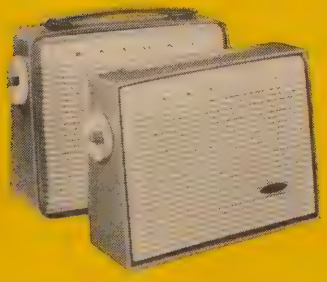
A wonderful addition to the "ham shack" two new 6 and 10 meter transceiver kits

They're combination transmitters, designed for crystal control, and variable tuned receivers operating on the 6 and 10 meter amateur bands (50 to 54 mc from HW-29 and 28 to 29.7 mc for HW-19) in either fixed or mobile installations. Highly sensitive superregenerative receivers pull in signals as low as 1 microvolt; low power output is more than adequate for "local" net operation. Other features include: built-in RF trap on 10 meter version to minimize TVI; adjustable link coupling on 6 meter version; built-in amplifier metering jack and "press-to-talk" switch with "transmit" and "hold" positions. Can be used in ham shack or as compact mobile rigs. Not for Citizens Band use. 10 lbs.

HEATHKIT AD-10 $33.95

HEATHKIT AA-20 $34.95



HEATHKIT XR-2L $34.95
HEATHKIT XR-2P $29.95

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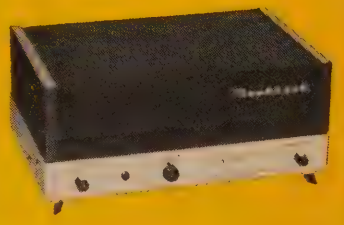
Assembled in only a few hours, both of these models incorporate superior design features that will give you portable listening enjoyment day after day. Vernier tuning control gives smooth, easily-separated station tuning. Large 4" x 6" PM speaker with heavy magnet provides "big set" richness of tone. Operates on standard size "D" flashlight batteries. Six Texas Instrument transistors.

XR-2L (simulated leather and plastic) 7 lbs.
XR-2P (high-impact plastic) 6 lbs.



HEATHKIT AA-30 $45.95

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Here it is! A new manual stereo record player kit

Made by famous Garrard of England, the AD-10 is a compact 4-speed player designed to provide trouble-free performance with low rumble, flutter and wow figures. Rubber matted heavy turntable is shock-mounted, and idler wheels retract, when turned off, to prevent flat spots. Powered by line-filtered, four-pole induction motor at 16, 33⅓, 45 and 78 rpm. Supplied with Sonotone STA4-SD ceramic stereo turnover cartridge with .7 mil diamond and 3 mil sapphire styli. 10 lbs.

It's easy and economical to go stereo with these two Heathkit "compatibles"— stereo preamp kit (AA-20)

Made for each other, either of these components can be incorporated with your present stereo system. The preamplifier (AA-20) features 4 inputs in each stereo channel and gives you a choice of 6 functions. It will accommodate a magnetic phonograph (RIAA equalized), a crystal or ceramic phonograph, and 2 auxiliary sources (AM-FM tuners, TV, tape recorders, etc.), and is completely self-powered. 8 lbs.

Hi-fi rated 14/14 watt stereo power amplifier kit (AA-30)

Two 14-watt high fidelity amplifiers, one for each stereo channel, are packaged in this single, compact, handsomely styled amplifier (AA-30). Ideal for use with the AA-20, any stereo preamp or with a pair of monophonic preamps, it features individual amplifier gain controls and speaker phase reversal switch. Output terminals accommodate 4, 8 and 16 ohm speakers. 21 lbs.

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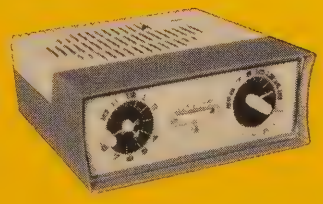

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Completely portable . . . superb modern styling in high impact plastic . . . powerful 6-transistor circuit operating from long-life mercury batteries or ordinary pen-light cells. Does everything you expect from a clock-radio—and costs you so little! Handsome cabinet measures only 3½" H. x 8" W. x 7½" D. for ease of placement anywhere in the home. Batteries not included. 5 lbs.

HEATHKIT GC-1

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New, all transistor "Mohican" general coverage receiver kit

The "Mohican" is the first all transistor communications-type receiver in kit form and first to use ceramic IF transfilters. Covers 550 kc to 30 mc on five bands, with five separately calibrated bands to cover amateur frequencies (including 11 meter citizens band). Powered by 8 standard size "C" flashlight cells. Built-in 54" whip antenna, flywheel tuning, tuning meter, and headphone jack. Truly an outstanding receiver! Batteries not included. 20 lbs.

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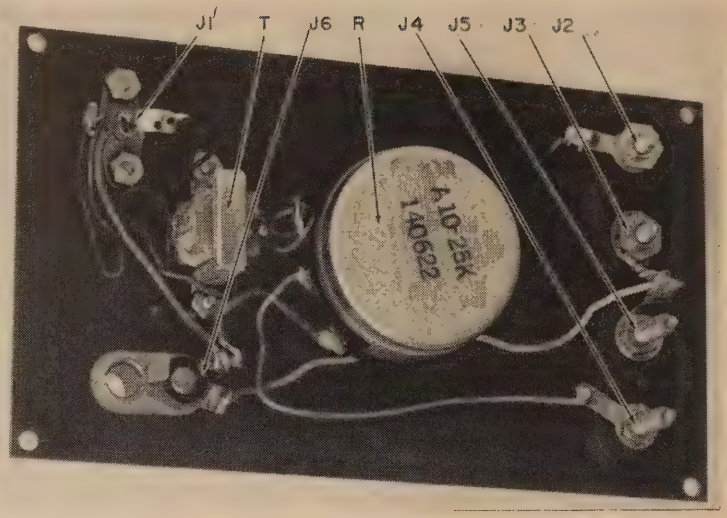


The limited number of parts makes construction fast and simple

(*Continued from page 66*)

suitable. (The difference impedance-wise has negligible effect.) For even greater accuracy, one of the many surplus shielded transformers could be used.

Potentiometer R is a 4-watt unit that has a linear taper. It is chosen not for its power-handling capacity but because it has a relatively large diameter and can provide higher accuracy. As shown in the photo, it is controlled by a large arrow knob moving over a hand-prepared calibration scale. For convenience, a headphone set is used to detect balance. A signal of approximately 850 cycles has been found suitable. The audio input amplitude may be between 5 and 10 volts.

From Fig. 2 it is obvious that C_x must be equal to or smaller than C_s to obtain a null. When R's arm is at the top, equal and opposite voltages are being applied to both capacitors, and null is obtained when they are equal. At any other setting, R reduces the voltage and requires a smaller C_x to produce a null. For example, at R's mid-scale, balance requires that C_x be one-half of C_s, and so on. This shows that R may be calibrated in terms of angle rotation and the divisions should be uniform. For maximum accuracy, however, it is better to calibrate directly from known capacitors.

Obtain four capacitors: 100$\mu\mu$f (two of them), 25 $\mu\mu$f and 50 $\mu\mu$f. Use a 100-$\mu\mu$f as the standard, and the second 100-$\mu\mu$f as the unknown. Set R to balance and mark off the null position as 100. For a check, transpose the capacitors and see if the same point is determined at balance. If not, divide the difference and mark off a point midway between the two null positions. Now with the 100-$\mu\mu$f as C_s, connect the 50-$\mu\mu$f at C_x, balance and mark off 50 at the appropriate point. With 25 $\mu\mu$f at C_x, mark the point 25.

It pays to use good standards for this instrument. Centralab type TCZ is excellent. They are 2% tolerance units with zero temperature coefficient, available in values from 12 to 100 $\mu\mu$f.

After determining the major divisions (0, 25, 50, 75, 100), fill in with smaller, equally spaced markings. Five small divisions for each major one should be adequate and will enable measurements *directly* in multiples of 5 $\mu\mu$f. Because the variation is uniform, you can easily interpolate between the smaller divisions.

An obvious method of extending range is to use different standard values. If you use .001 μf, you can measure unknowns 10 times *greater* than your original calibration. On the other hand, with a 10-$\mu\mu$f standard you can measure 10 times *smaller*.

A different method is used here to extend measurements above 100 $\mu\mu$f. Transpose the capacitors by connecting the standard at C_x and the unknown at C_s. Now you can measure conveniently from 100 $\mu\mu$f (with a 100-$\mu\mu$f standard) up to .001 μf. The new calibration is found by calculating from $\frac{10{,}000}{D}$ where D is the original calibration. Thus, 400 $\mu\mu$f on the high range corresponds to the 25-$\mu\mu$f point on the low range, etc. The list shows corresponding points.

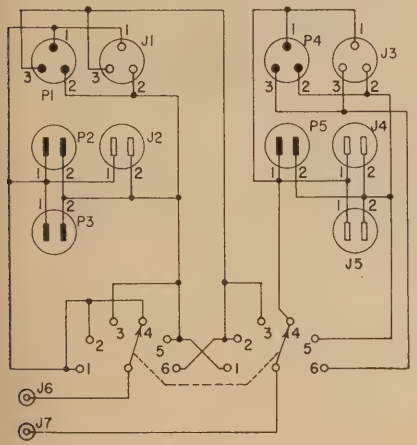
Low Range	*High Range*
10	.001
20	500
25	400
30	333
35	286
40	250
45	222
50	200
55	182
60	165
65	154
70	143
75	133
80	125
85	118
90	111
100	100

Note that *the high range is not a linear one*, so be careful when interpolating between marked divisions.

With both ranges on a single scale you have a wide-band, accurate bridge requiring but a single standard. END

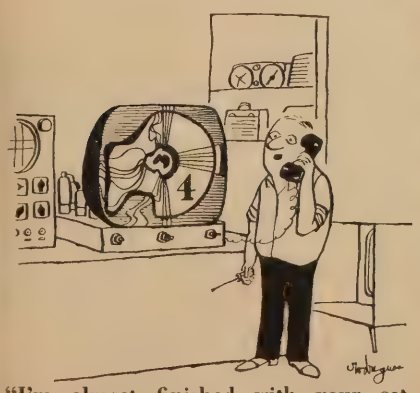
HANDY CABLE CHECKER

BECAUSE of the large number of cables used with our PA equipment, we found it convenient to construct a simple cable checker as an aid to periodic cable testing. The cable connectors are plugged into the matching connectors on the checker and the rotary switch turned through its various positions while observing an ohmmeter which serves as a short–open indicator. Although the connectors on our equipment have been standardized to suit our own requirements (P1, P4, J1, J3—Amphenol mike connectors; P2, P5, J2, J4—Jones cable connectors; P3, J5—ac power connectors), other types may be accommodated by wiring additional connectors in parallel. Ohmmeter indications for the six switch positions are:



Switch Position	*Ohmmeter Indication*
1	Infinite, or leads 1 and 2 are shorted
2	Infinite, or leads 1 and 3 are shorted
3	Infinite, or leads 2 and 3 are shorted
4	Finite, or lead 1 is open
5	Finite, or lead 2 is open
6	Finite, or lead 3 is open

—Warren J. Smith



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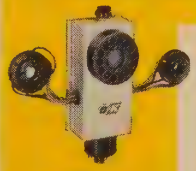

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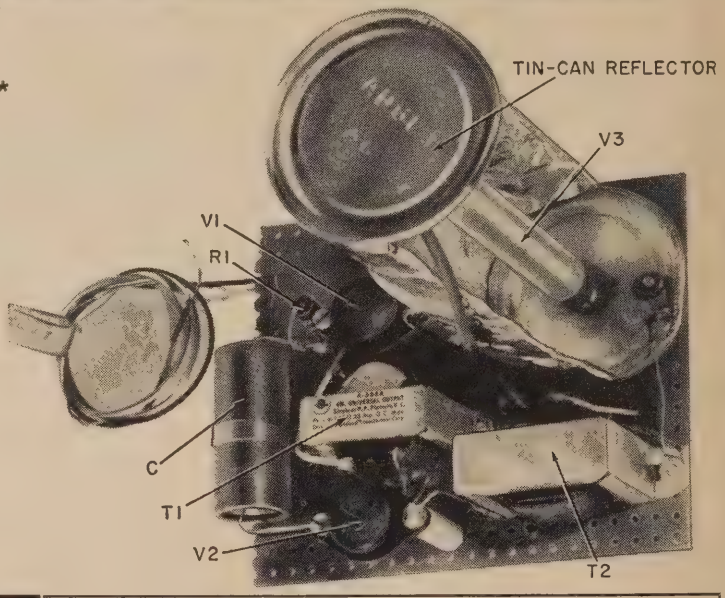


BENCH TESTED

Checked out by one of the magazine's staff, this little unit blinked regularly and apparently reliably during the period it was watched. It was clearly visible about two blocks away. This would make it useful for most warning signals, but might not be adequate for "changing a tire at night" as the author suggests, on a high-speed highway, especially if confused with the glare of opposing headlights. For such purposes the conventional red flare is still supreme.

At one time or another we have all seen the flashing lights used on the tops of street barricades guarding excavations or detours. Many times I have been asked about the possibility of packaging this type of unit for automobile use as a portable electronic flare. It would be used as a warning signal when changing a tire at night, etc.

For some time my answer to such questions was "much too unreliable," as the majority of these lamps are electromechanically operated. Transistors have shed new light on the scene.

Types of flashers

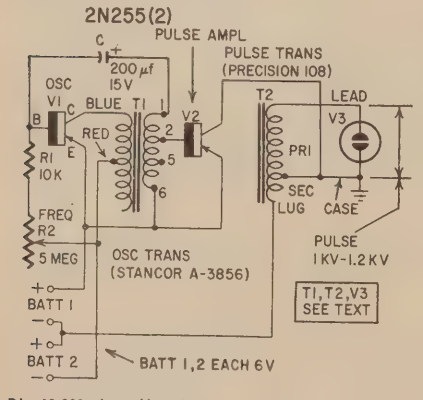
Today, there are two ways to use transistors to produce light flashes. Both use a metronome type circuit in which one transistor pulses a second which is biased to cutoff. One such circuit uses two germanium transistors (one n-p-n and one p-n-p) with a small tungsten lamp in the collector lead as the light source. This setup requires either a 3- or 6-volt battery. The circuit offers simplicity, few parts and good battery life. However, a study of tungsten lamps indicates that on–off cycling is a decided factor leading to short and unreliable bulb life. For commercial uses where many multiple units are installed on a barricade, this may not be serious. But for reliable operation it is not acceptable.

The second and most reliable method uses a gas tube for the light flash. Again a metronome type circuit is used (see diagram). Transistor V1 generates pulses over a range of about 60 to 120 a minute. The optimum pulse rate is 90 flashes per minute. The unit shown in the photos is set at this pulse rate by using a single fixed resistor in place of the series R1–R2 combination. Transformer T1 provides a low-impedance path between V2's base and emitter and supplies low-voltage high-current pulses. The circuit operates from 3 to 6 months on one set of batteries.

Capacitor C's value is not critical and can be varied over a wide range—100–500 μf—and remain in a usable flashing range. Two low-cost 2N255 power transistors are used. No heat sink is needed. A lug is installed under the head of the screw holding the transistor down and is used as the collector connection. Connections to the base and emitter are soldered directly to the ends of the pins.

Almost any output transformer can be used for T1. Select the output impedance tap that gives the best performance. Again, this is not critical.

The most critical components in the circuit are output transformer T2 and the gas tube. I used the transformer from a Precision Radiation Co. model 108 Geiger counter (model 108 transformer). This unit can be had from the firm, 4223 W. Jefferson Blvd., Los Angeles, Calif., as long as its supply lasts, or the units in the parts list can be substituted. Connect the substitute units—they are filament transformers—as autotransformers and use just like the 108.



R1—10,000 ohms, ½ watt
R2—pot, 5 megohms, linear taper
C—200 μf, 15 volts, electrolytic
BATT 1, 2—6 volts (RCA VS009 or equivalent)
T1—universal output transformer, single or push-pull plates (4,000–14,000 ohms) to voice coil (Stancor A-3856 or equivalent)
T2—see text (Precision Transformer model 108, Stancor P-4026, or P-8190 or equivalent)
V1, 2—2N255
V3—gas tube (see text)
Chassis board
Reflector
Miscellaneous hardware

Circuit of 2-transistor flare.

The flash tube

For the gas tube you can use a short piece (6–8 inches) of neon tubing, made up by a local neon sign shop (preferably *zeon* tubing), or, much cheaper, a 4- or 6-watt fluorescent lamp.

For best results use a reflector behind the lamp. You can make one from a tin can lined with aluminum foil. By using colored cellophane around the lamp, either red or amber flashes can be obtained. During the day, light output will seem rather dismal, but at night it is more than ample.

The major source of trouble with this type unit is pulse-transformer breakdown. The high-voltage spikes from the transformer reach much higher values than the actual firing voltage of the gas tube. If transformer insulation is at all weak, it will break down. If this happens, get a transformer with better insulation or a gas tube with a lower firing voltage. END

* Chief engineer, Rho Engineering Co.

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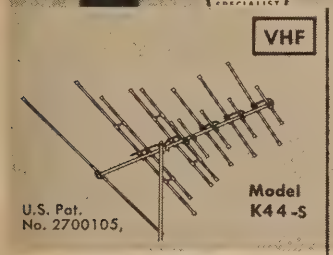

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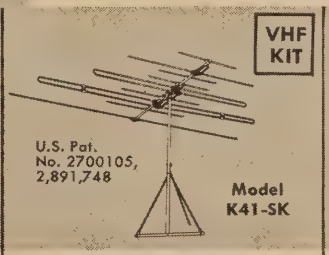

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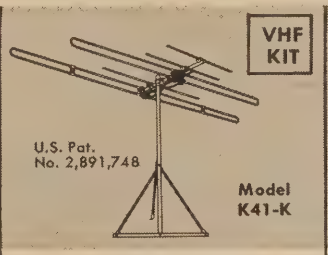

POWERBEAM

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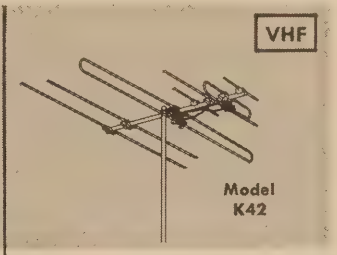

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Ideal replacement for old style "Con Yagis". Full-power gain on all channels 2-13. Stacking increases power 84%. **List, $13.00.**

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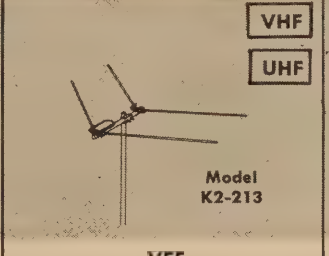

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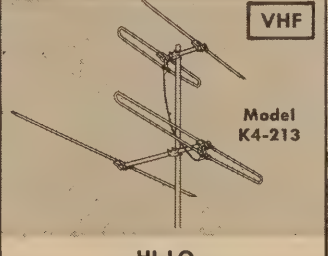

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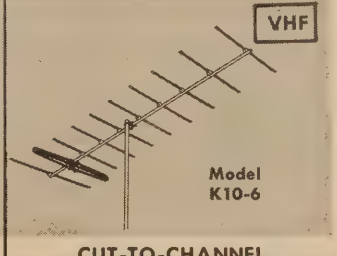

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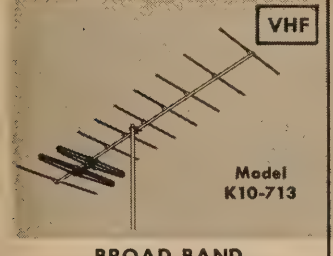

BROAD-BAND

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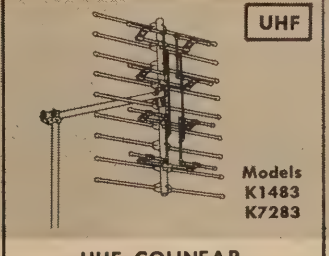

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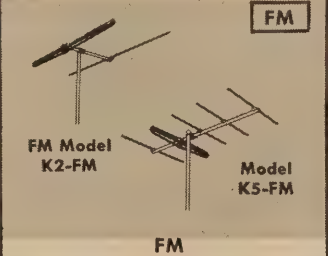

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What's With CHARACTERISTIC IMPEDANCE?

We take a few swipes at Professor Egghead and show that characteristic impedance isn't so difficult after all

By ROBERT G. MIDDLETON

CHARACTERISTIC impedance sounds like one of the higher confusions, but it is really very simple. The only reason it seems difficult is that it has been explained mostly by college professors who are trying to show how smart they are. You know, BS, followed by MS and then by PhD. Everybody knows about BS, etc. But take a look at Fig. 1.

By forming a chain of resistors and checking with an ohmmeter as we make the chain longer and longer, we find that the input resistance is coming to a *limiting value* of *300 ohms*.

And, if we do as shown in Fig. 2 and terminate *any* length of chain with a 300-ohm resistor, the input resistance is *always* 300 ohms.

But you better buy the resistors wholesale. That way, they are cheap at half the price.

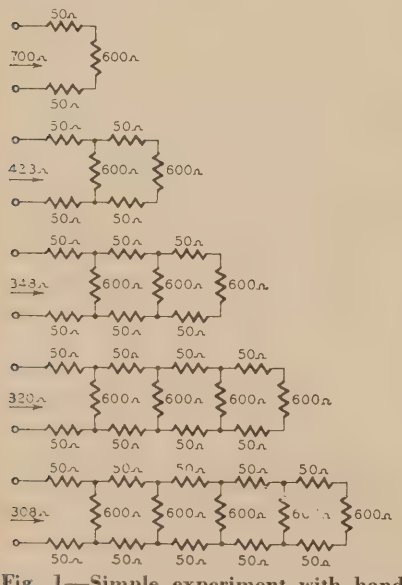

Fig. 1—Simple experiment with handful of resistors and an ohmmeter proves a resistor chain rapidly approaches a limiting or constant value of input resistance.

Sometimes it's difficult for us to look at the chains in Fig. 1 and believe that the input resistance is settling down to 300 ohms. We seem to feel that, if we go on adding shunt resistors, the input resistance must keep going lower and lower. *But it doesn't.* It settles down to a limiting value, and this is the *characteristic resistance* of the chain—300 ohms, no more, no less.

A settled-down chain is pretty long, like a giraffe's neck.

You remember about the local yokel who went to the circus, took a look at a giraffe and said, "There ain't no such animal."

Hold your hats, boys—this one almost nobody is going to believe.

Enter Professor Egghead

Let's make like Professor Egghead, BS, MS, PhD. (MS means more of the same.)

Eggy says that we ought to do it the hard way, using the quadratic equation. That way, almost *nobody* knows what we are talking about, and that's good according to Eggy. Oh yes, PhD means Piled high and Deep.

Well, anyhow, according to Eggy, you take a section of the resistor chain and terminate it with R, as shown in Fig. 3. We don't know what R is, but we will say it is the characteristic resistance of the chain. So, that would make the input resistance of the chain equal to R also.

All we got to do now is find R! To do it the hard way, we have to use the quadratic formula that says $Y = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$. Who said where's the DDT?

So when we put in the 50's and the 600's $\left(R = 50 + 50 + \frac{600R}{600 + R}\right)$ and solve the dad-blamed equation, we come out all right—we get 300 ohms, just as we would if we had good sense and used an ohmmeter.

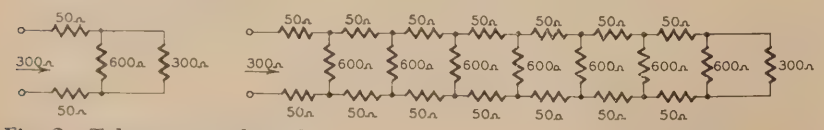

Fig. 2—Take any number of sections in a chain, and terminate them with the characteristic resistance, and the input resistance is the same.

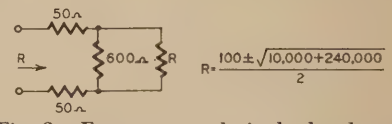

Fig. 3—Eggy says to do it the hard way, like this. What we find in the quadratic equation shouldn't happen to a dog, but it does.

But not so fast, Eggy. You have throwed out the baby with the bathwater. Honest.

Here's how you done it. That quadratic formula gave us *two* answers. It was trying to tell us something. It gave us a +300 ohms, and a −200 ohms. We threw out the −200 ohms because that's the sloppy way we do things in the ivory tower.

The quadratic formula was trying to tell us something, and we wouldn't listen.

Bend an ear. If we terminate our resistor chain with −200 ohms, it works out. The input resistance is −200 ohms! The solution is a *negative* resistance. What is a negative resistance? Well, it is the resistance that you have in a dynatron or transitron or electric arc. It is as real as positive resistance that we have in composition resistors, lamp filaments or what have you.

So we come to the "Ain't no such animal" again, only this time its neck is out a mile. A resistor chain can be terminated with proper values of *either* positive or negative resistance, and the input resistance will be the same as the terminating resistance.

Believe it or not, we can make up a resistor chain a mile long and, if we terminate the chain with its negative characteristic resistance, that negative resistance will be reflected back, section by section, the whole mile, to make the input resistance the same value of negative resistance. Ho hum.

Why don't you tell us these things, Eggy?

Going back to Fig. 1, we don't have to use 50- and 600-ohm resistors. These happen to give us a characteristic resistance of 300 ohms.

But actually, we can select *any* values we want to, and we will always

have a characteristic resistance. It won't be 300 ohms. It might be 75 or 600 ohms. But *any* resistor chain like Fig. 1 always has a characteristic resistance.

In fact, it always has *two* characteristic resistances. It will have a positive characteristic resistance and a negative characteristic resistance.

It's just like the definition of a filter —"a filter is any combination of coils and capacitors." I like definitions of this sort, even if Eggy don't. They help to make life more simple. But they don't cut much ice in the ivory tower, seems like.

Coils and capacitors

Let's fiddle around with coils and capacitors a little, instead of resistors.

If we make up a chain of 13-$\mu\mu$f capacitors and 1.17-μh coils, we have the same thing as in Fig. 1, only

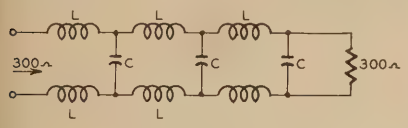

Fig. 4—Any chain of L and C has some characteristic impedance. When C = 13-$\mu\mu$f per foot and L = 1.17-μh per foot, characteristic line impedance is 300 ohms.

different. But it is the same difference. If we terminate the chain with a 300-ohm resistor, an ohmmeter shows 300 ohms at the input of the line.

And now, we can use either an ac or dc ohmmeter. And the input resistance is still 300 ohms for ac or for dc.

Take a couple of parallel wires with a wire diameter to give 1.17 μh per foot, and space them to give a capacitance of 13 $\mu\mu$f per foot. We will then

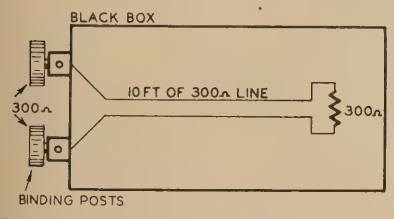

Fig. 5—If 10 feet of 300-ohm line is in a black box and terminated with 300-ohm resistor, there is no way of telling the box contains anything but a 300-ohm resistor.

find a characteristic resistance of 300 ohms for this line.

Take the deal in Fig. 4. All the L and all the C cancel out at *all* frequencies. The same thing on a 300-ohm ribbon line. If you terminate the line with a 300-ohm resistor, you wouldn't know that there was any inductance or capacitance.

To show what we mean, look at Fig. 5. If we have 10 feet (or 100 feet) of terminated 300-ohm line in a black box, no tests at the terminals are possible which will show anything but a 300-ohm resistor in the box.

In other words, the input impedance of the line is purely resistive.

Time for a short beer. END

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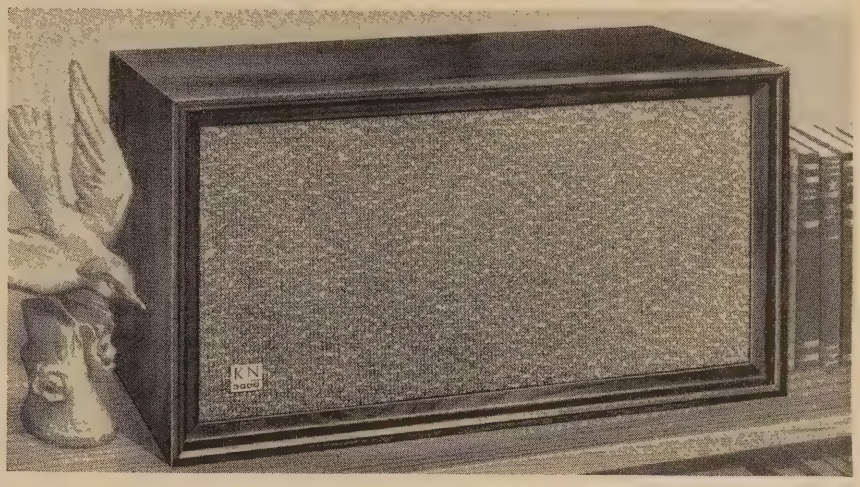

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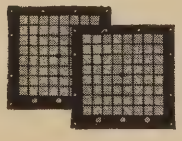

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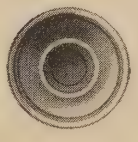

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ELECTRONICS in the CLASSROOM

Third of a series, this article discusses teaching heat, thermocouples and Geiger counters with the help of electronics

By SOL D. PRENSKY*

THE first two articles in this series (February, 1959, page 46 and May, 1959, page 44) clearly showed how modern electronic equipment can be used in the science classroom to provide clear and interesting demonstrations of physical properties.

The principles of heat can also be demonstrated in an equally interesting fashion.

Electricity from heat

Thermo-elements for converting heat into electricity have been very much in the news—the possibility of obtaining usable quantities of electricity directly from the heat of a nuclear reactor and the remote indication of critical temperatures in space vehicles have been widely publicized.

Both functions are possible because an emf is produced by raising the temperature of a junction of two dissimilar metals. Although this effect was discovered by Seebeck more than 100 years ago—in 1826—recent research into solid-state physics has uncovered exciting new possibilities for much improved thermo-electric materials. For example, a report from Dr. Raymond Bowers of the Solid-State Physics Dept. of the Westinghouse Research Laboratories indicates developments in thermo-elements that point toward sizable amounts of electrical power produced from very-high-temperature sources.[1] There is also a real possibility of utilizing the reverse action (the Peltier effect, 1834) where cooling is produced by forcing an electric current through a similar thermo-electric junction in the reverse direction.

Leaving the newer possibilities (many of which are classified as to their details) for future development, we will concentrate on the conventional thermo-elements presently available to illustrate the basic thermo-electric property of producing a measurable electrical output by applying heat. It is important at the outset to realize that a single thermocouple produces very little electrical power when heated by a laboratory burner, so even the detection of this electrical output on an ordinary meter is not very easy to show.

Taking an ordinary thermocouple (iron–constantan) as an example, the generated voltage may be expected to be in the order of around 50 μv per degree Centigrade, and is fairly linear with temperature rise. So for a rise of 100°C, an output voltage of around 5 mv may be expected. This small output is very difficult to detect with the general-purpose type of meter ordinarily found in the laboratory. On the familiar 0–1-ma meter range for example, the nominal short-circuit current reading at 100°C would be limited by the internal resistance of the meter (around 100 ohms), and therefore would show an approximate deflection of only 5 mv divided by 100 ohms, or .05 ma, which would be barely readable. It would not help to try switching to a more sensitive current range since the meter's internal resistance would increase correspondingly and the meter deflection would still be disappointingly small.

The difficulty in obtaining a direct reading of thermocouple output on an ordinary current-operated meter (whether ammeter or voltmeter) can be overcome by using more sensitive indicators (electronic galvanometers, millivoltmeters or null-reading potentiometers) or a combination of thermocouples to get a larger electrical output. The latter method will be used here in the form of a commercial thermopile, which consists of a large number of individual thermocouples in series.

The thermopile used in the first demonstration (Minneapolis-Honeywell Powerpile model CS 82) is particularly effective. When heated by a flame, it can supply up to about 500 mv (0.5 volt) on open circuit, and around 100 ma on short circuit. The current shown on a milliammeter in series with it will, of course, be decreased by the internal resistance of the indicating meter, but will still be more than enough to produce a good deflection on the demonstration meter. The same thermopile can also be employed as the sole source of energy for a transistor amplifier circuit, as is shown in a subsequent demonstration.

The simple arrangement for measuring the current output of the thermopile (as would be done in temperature measurement by pyrometer) is shown in Fig. 1. The source of heat can be any flame (even from a match) but preferably from a Bunsen or alcohol burner. The large-size demonstration multimeter (Hickok 209A) should be set on its 120-ma range, and a substantial deflection should be obtained after the thermopile has been heated for 2 or 3 minutes. (Note that the flame should be directed at the edge of thermopile opposite the one where the leads come out.) With a suitable calibrating source,

(*Continued on page* 80)

*Prof. E. E. Dept., Fairleigh Dickinson University, Teaneck, N.J.

[1]News Briefs, RADIO-ELECTRONICS, June, 1959, page 6.

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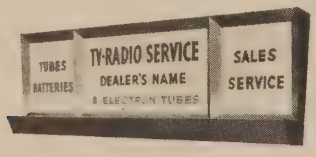

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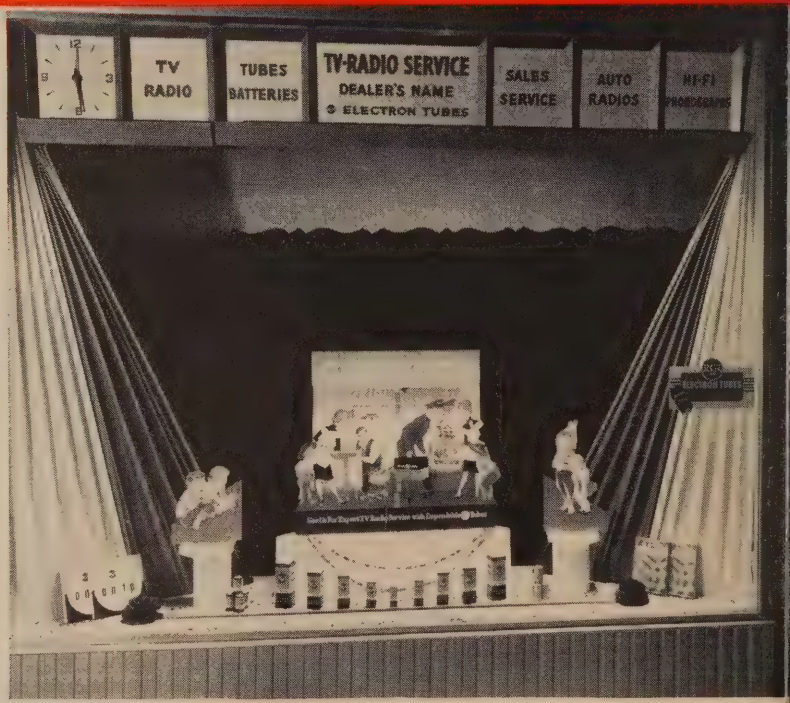

A good looking store front is your first opportunity to convert a passerby to a customer. The RCA Store Improvement Program offers you the elements to make your store front a working partner in your business.

Talk to your Authorized RCA Tube Distributor about this exciting plan right away. Ask him for your copy of RCA's new Store Improvement Guide (4F257), with a complete list of the components available and the order forms to secure them. Find out how easily and quickly you can add those few extra touches to your store to give it that Successful Look for 1960.

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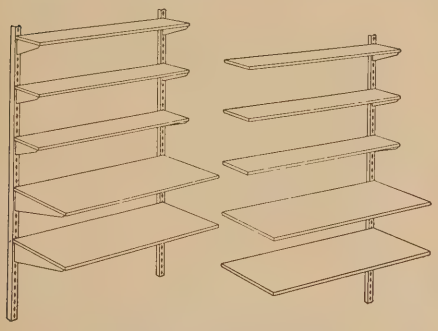

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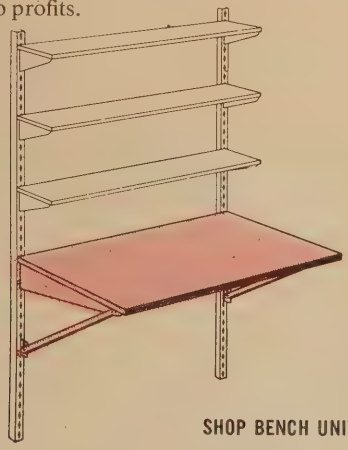

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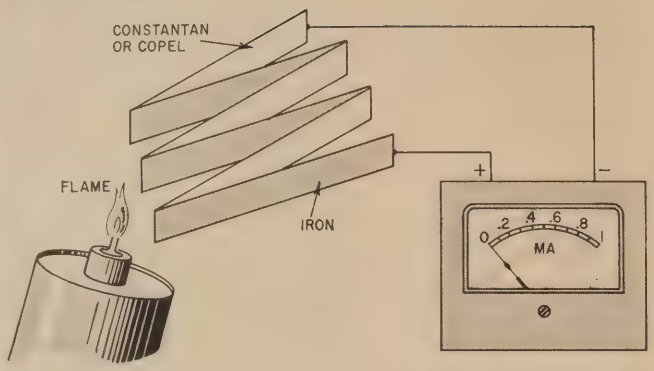

Fig. 1—Measuring the current output of thermocouples connected in series to form a thermopile.

(*Continued from page* 76)

the meter could then be marked off as a remote temperature indicator.

Heat-powered electrical devices

The fascinating possibilities that are opening up as a result of advances in thermo-electric conversion can be demonstrated with the same thermopile. Although the newer arrangements for high-efficiency conversion (such as cesium–plasma couples) are still in the experimental stage, the thermo-elements that are commercially available can power flea-power circuits, which the undemanding transistor has made possible. Miniature hearing aids, audio oscillators and radio receivers using headphones are a few examples.

The circuit used here is that of a simple transistor audio oscillator which will produce an audible tone from a loudspeaker, using either an alcohol flame or cigarette lighter as the only power source.

For classroom demonstration, we want the sound to come from a loudspeaker rather than headphones, and this arrangement using a Bunsen burner or alcohol lamp is discussed first. (The do-it-yourself version using a match or cigarette lighter is covered later.) The overall appearance of the sound-from-heat class demonstration unit is shown in Fig. 2, and the circuit of the transistor oscillator in Fig. 3. A medium-power 2N186-A transistor is connected in a positive-feedback circuit. Variations in collector current flowing in the upper half of the transformer primary are fed back to the base through the lower half of the primary winding, supplying positive feedback for oscillation. Base bias current is regulated by the 10,000-ohm variable resistance of R2 in series with fixed resistor R1, and bypassed for ac by capacitor C1. The resulting audio oscillations are fed to the 45-ohm speaker by the voice-coil winding. Using the 45-ohm intercom type speaker requires a smaller stepdown ratio in the transformer, thus conserving as much as possible of the small voltage (and relatively large current) delivered by the thermopile. The setup will also work with a conventional 4-ohm speaker and output transformer if the primary's dc resistance is kept low. The pitch of the resulting tone is initially set by C2's value, and can be varied slightly with R2. No switch is used; the unit

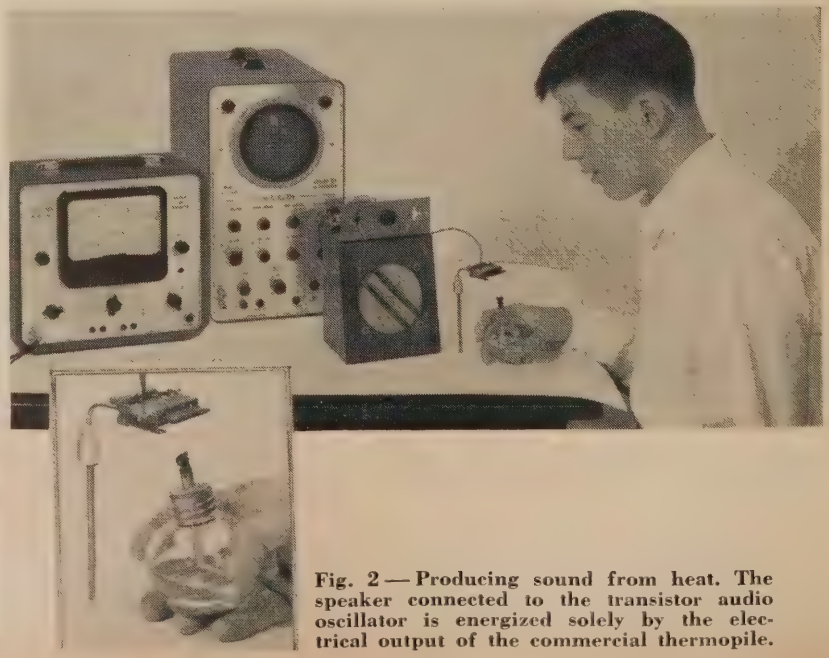

Fig. 2 — Producing sound from heat. The speaker connected to the transistor audio oscillator is energized solely by the electrical output of the commercial thermopile.

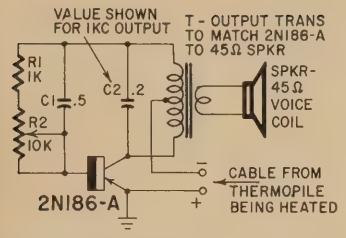

Fig. 3—Schematic of transistor audio oscillator that can be powered by thermopile's output.

simply starts up when the business end of the thermopile has become hot enough (in 2 or 3 minutes), and stops by itself when the thermopile cools off. The thermopile is commercially available as a pilot control for gas burners (Minneapolis-Honeywell Powerpile CS82A1X-32X15, list price $9.30).

The do-it-yourselfer can make his own thermocouples and thermopiles from the raw materials in the form of metal strips or ribbons. He can then build electronic devices that can be powered by these home-built thermoelements. The metallic raw material can be purchased from scientific supply houses, generally in spools. For kit builders (some call themselves thermoelectronicists), a complete line of parts, kits and literature is available for making thermal batteries of the "zig-zag" and disc types, some having a 2-volt output.[2] A very simple kit for an electronic device that requires little supply power is the Knight-Kit headphone code oscillator circuit shown in Fig. 4.

Temperature-sensitive resistor

The change in resistance of a conducting material with temperature is used to make another form of temperature-sensitive transducer. This type is widely used to measure small temperature changes in an electrical form for remote indication or telemetering, as from a space vehicle. In its older form, where the positive temperature coefficient of the resistance of a pure metal was used, the method was fairly insensitive. Platinum wire, for example, is typical of the pure metals, with a temperature coefficient (α) of approximately +.004. When a length of platinum wire that has a resistance of 100 ohms is heated to 25°C above room

[2]Thermo-electronicist kit supplier is Hermon E. Cotter, 15766 Blackstone, Detroit 23, Mich.

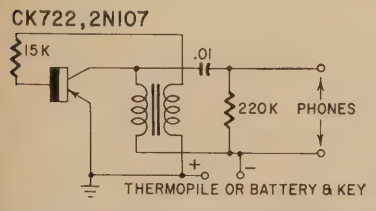

Fig. 4—Headphone type of code-practice oscillator suitable for operation from modest output of a home-made thermopile.

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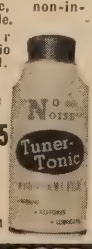

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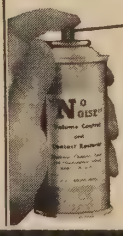

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temperature, its resistance goes up to 110 ohms. By comparison, the new semiconductor materials are much more sensitive. Their temperature coefficient is negative and of the order of —.04. Because this change with temperature is much faster than that of a metal (and in the opposite direction), a ratio based on absolute temperature is used to plot the unit's resistance.[3] Such a table for a 100-ohm thermistor (Glennite 21TE1) shows that the new resistance at 25°C above room temperature would be 40.6 ohms. So for the same 25°C change in temperature, the resistance of the platinum increases by about 10%, while that of the semiconductor thermistor decreases by about 60%. This substantial change in thermistor resistance with small change in temperature can easily be detected and displayed on an electrical instrument.

Detecting temperature changes

A circuit using a thermistor as one arm of a Wheatstone bridge is shown in Fig. 5. The thermistor (Glennite 31CB1) has a nominal resistance of 1,000 ohms at room temperature (25°C). The bridge is arranged with equal arms of 1,000 ohms for R1 and R2. Potentiometer R3 in series with the 220-ohm fixed resistor R4 allows this arm to produce a balance when the total resistance of R3 plus R4 is set to

[3]See table in thermistor bulletin of Gulton Industries, Glennite Thermistor Div., Metuchen, N.J.

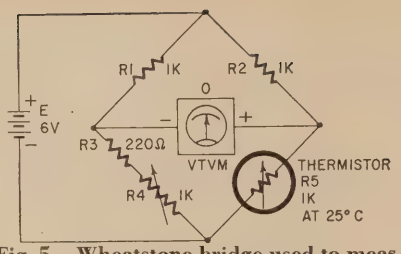

Fig. 5—Wheatstone bridge used to measure temperature changes.

equal the actual thermistor (R5) resistance. R4 allows for enough variation of its arm to restore balance when the thermistor responds to a change in its surrounding (ambient) temperature.

The indicator is a large-size vtvm previously used in Parts I and II as a demonstration meter. This time it is used on its zero-center 1.5–0–1.5 volts dc range. When used in this manner, a change of 5°C in the temperature of the thermistor (coefficient —3.9%) will cause its resistance to change to 830 ohms (or about five-sixths of its original value). The corresponding unbalance voltage (ΔE) can then be expected to be around ¼ volt, a value easily read on the demonstration meter.[4]

As an alternative method of indicating the change in resistance, potentiometer R4 could be marked off to read the temperature directly from the amount of resistance required to restore the bridge balance. Either way, the bridge method for indicating the change in resistance offers an important advantage over simpler ohmmeter methods in that negligible current is taken by the dc vtvm indicator at balance. When used with refinements that take into account such matters as resistance of the leads, the heating effect of the current through the thermistor, and high galvanometer sensitivity, this bridge method can detect a temperature change as small as .0005°C, or about one part in a million at room temperature. (See Partridge reference.)

[4]ΔE can be predicted from the equal-arm bridge expression:

$$\Delta E = E\left[\frac{1-\alpha}{2\ (1+\alpha)}\right]$$

where α is the ratio of the new thermistor resistance to the old (5/6 in this case).

Radioactivity

The subject of radiations from radioactive material is very broad. The present discussion of the demonstration of the detection of radioactivity and indicating its relative intensity is, of necessity, limited in its scope and restricted to that portion of the field that concerns only one common method of indicating the relative intensity of any radioactivity present. This type of survey meter employs a Geiger-Muller tube in a Geiger counter arrangement. With the understanding that this demonstration must be regarded merely as an introduction to this highly important topic, a bit of background on the various

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types of radiation makes a good starting point.

Most of us are familiar with the term radiation, as applied to the naturally radioactive substances uranium or thorium (and their byproduct, radium). We also recognize the primary radiations that constantly emanate from them in three forms:

▸ **Alpha particle** (α)—the positively charged nucleus of a helium atom.

Composition: 2 protons, 2 neutrons, giving it a charge of +2 and a weight about 4 times the hydrogen atom.

Range: Travels about 1 inch in air, and is stopped by a piece of paper or, to all practical purposes, by the skin.

▸ **Beta Particle** (β)—an elementary charge of electricity.

Composition: 1 electron, giving it a charge of −1, and a weight about 1/1,850 that of the hydrogen atom (or about 7,500 times lighter than an alpha particle).

Range: Travels a few feet in air and is stopped by an inch of wood.

▸ **Gamma ray** (γ)—radiant energy.

Composition: Very high-frequency photon having no charge or weight.

Range: Great distance through air and correspondingly smaller distances through concrete or lead. (The greatest danger to living cells is from these highly penetrating rays.)

To the three radiations from the naturally radioactive material must be added the radiations possible from man-made radioactive materials—the radioactive isotopes which are being produced in ever-increasing quantity. This is not the place to discuss the protons, neutrons and other elementary-particle manifestations in nuclear reactions. Suffice it to say that they are fundamentally important to all of us. Knowing that these radiations cannot be seen, heard, smelled, tasted or felt, we should also all know how they can be detected.

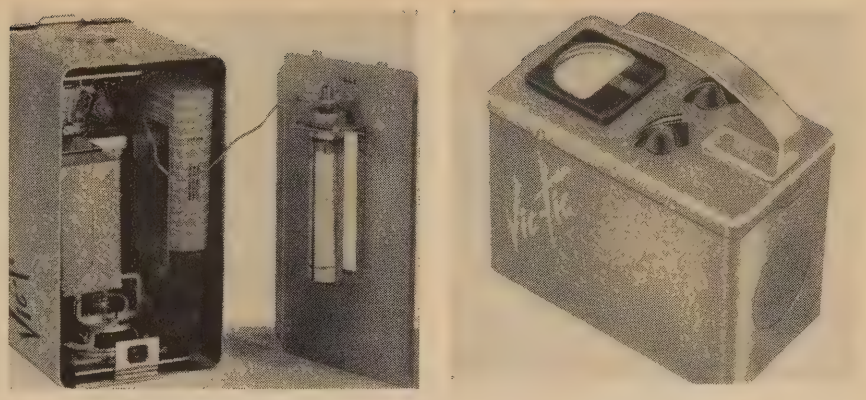


Fig. 6—Bottom (left) and top (right) views of the Vic-Tic portable Geiger counter. The Geiger-Muller tube is mounted behind the window in the instrument's bottom.

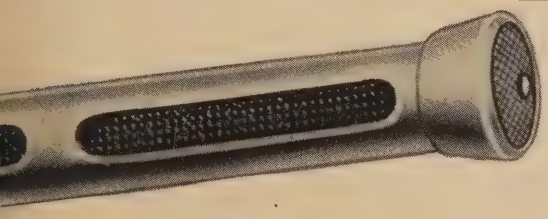
The various methods of counting radioactive radiations are based chiefly on the ionizing properties of the radiations. This is true for all of the three most commonly used methods:

▸ The simplest — the photographic film method. Blackening of the photographic plate is caused by the ionizing effects of the radiations on the silver compounds in the film emulsion.

▸ The most sensitive—the scintillation counter. Ionizing particles cause a phosphorescent screen to produce flashes of light, which are seen and greatly amplified by a photomultiplier tube, and then counted.

▸ The most commonly used—the Gei-

(*Continued on page* 88)



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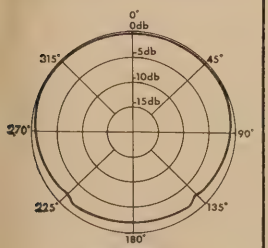

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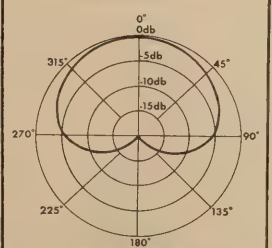

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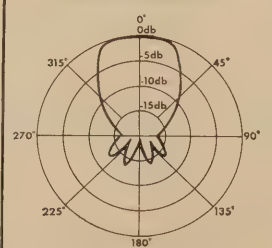

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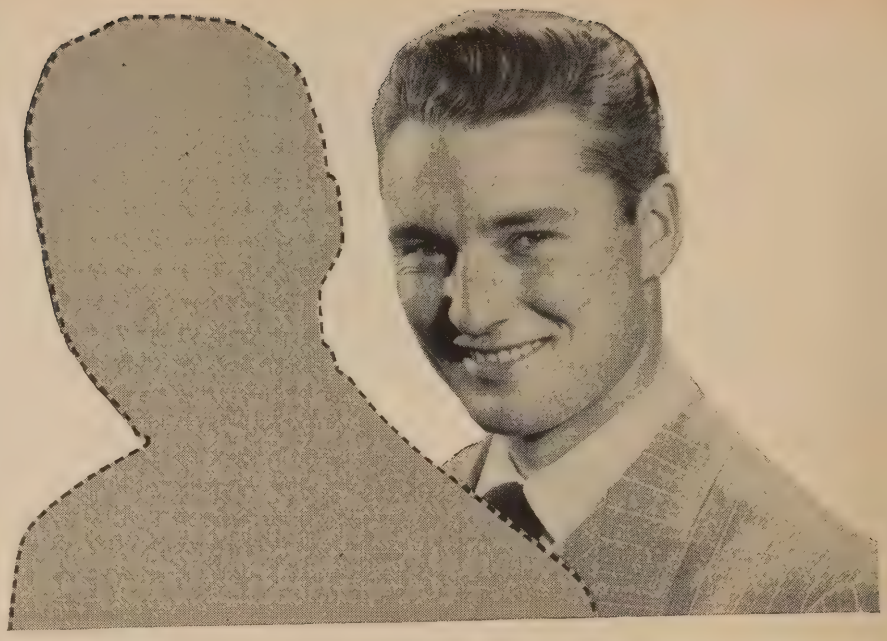

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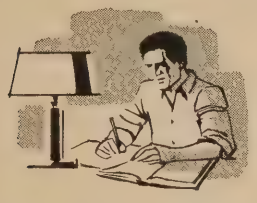

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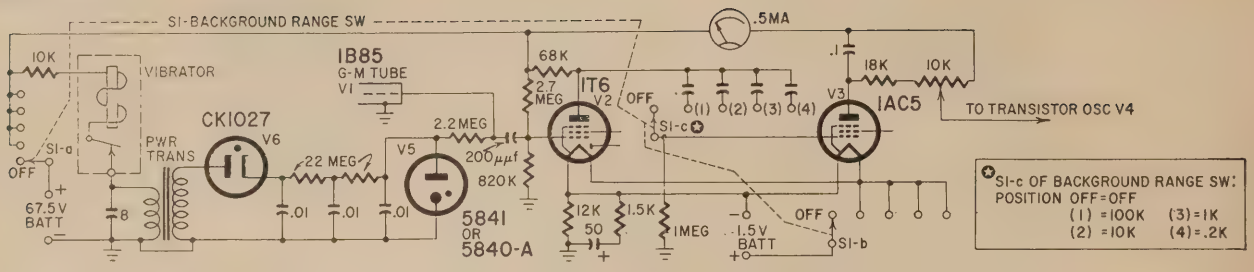

Fig. 7—Functional circuit of Geiger-counter type of radiation detector.

(*Continued from page* 83)

ger counter. A pulse of ionization resulting from the passage of a single ionizing particle through the gas of the G-M tube is amplified and counted.

The last method is selected for use here because the Geiger detector responds to all types of radioactive radiations, regardless of whether the ionization results directly from a primary source, such as an alpha or beta particle, or indirectly from a secondary source, such as a photo-electron produced in the gas by the passage of a gamma ray. (This method may also be extended to neutrons, which produce no ionization directly, but do eject ionizing protons from suitable materials. The protons in turn ionize the gas in proportion to the number of neutrons that produced them.) As a result of the ionization, produced either directly or by secondary radiation in the G-M tube, the count of the ionizing events provides a measure of the overall intensity of the radiation.

Geiger-counter demonstration

The appearance of reasonably priced portable Geiger counters, popular for survey purposes, as a radiation-danger monitor, and also in amateur uranium prospecting, is shown in Fig. 6. The rear view shows the silvered surface of the Geiger tube behind the window in the base of the case. The tube itself consists of a central wire conductor in a thin-walled metallic envelope that encloses the low-pressure gas within the tube. The walls of the window and tube are kept thin to allow the passage of energetic beta rays in addition to gamma rays. In operation, about 900 volts dc is applied to the inner conductor so the tube operates in its "plateau" region. (This is the sensitive voltage region at which the gas is well below its glow-discharge level, but is responsive to any radiation that produces an ionizing event and gives an electrical pulse as an output.) The top view shows the indicating meter and the sensitivity selector switch (left) as the main control. (The right-hand knob simply controls speaker volume.)

A simplified functional schematic circuit of the Geiger counter is shown in Fig. 7. Two batteries form its power supply—a 1.5-volt unit for the amplifying tube filaments and a 67.5-volt unit, both for the plate supply of the amplifying tube and for the vibrator producing the 900-volt potential applied to the Geiger tube.

Starting with the 900-volt high-voltage arrangement, the 67.5-volt battery feeds the vibrator. The vibrator's interrupter action induces high-voltage inductive kicks in the transformer's secondary which are rectified by rectifier V6, filtered by the R-C combination and stabilized by the 900-volt 5840 glow-tube (V5). The positive side of this high voltage is applied to the central conductor of the 1B85 Geiger tube (V1).

With the Geiger tube energized, we can trace the arrival of an ionizing event, such as a cosmic ray, which is a natural phenomenon constantly occurring at random. The electrical pulse resulting from the ionization by the cosmic ray is fed to the input of the two-stage amplifier, which charges the integrating capacitor in the plate circuit of the first stage and which produces a proportionate current pulse in the meter in the plate circuit of the second stage. A transistor oscillator is also connected to the output of the second stage so each pulse can be heard as a separate chirp in the speaker if the counts come slowly enough. This is the situation when the selector switch is set to its most sensitive position. Since these random pulses come too slowly for the meter to assume a steady average position, the background count is made by counting the chirps for a few minutes, and getting an average.

After the background count has been established (the position of the instrument, whether horizontal or vertical, is not significant for this count), a standardizing radioactive sample (provided with the instrument) is held against the instrument's base. The chirps quickly merge into a tone (indicating counts too rapid to count) and the meter needle tends to go off scale. The selector switch is now placed to a less-sensitive range position and the reading of the meter is taken, 375 counts per minute. Subtracting the background count of about 35 gives 340 counts per minute as an indication of the activity of this particular sample, which corresponds (for this quantity of sample) roughly to ore containing around 0.5% of uranium.

For comparing other radioactive sources, the radium-coated dial of a wristwatch will provide a good example (see Fig. 8). When held against the base, the reading obtained was about 4,000 counts per minute, indicating radiation activity around 10 times greater than the sample of ore. (This is not surprising—the radium used on the dial face has been greatly refined.)

There are many varieties of Geiger type survey meters on the market, with various probes and refinements. Further experiments, such as testing different shielding material in varying thicknesses, use of special probes for discriminating between types of radiations and determination of the half-life of a radio isotope, must be left for later consideration. With this introduction, it is hoped that a good intelligent start can be made toward a better presentation and understanding of this important area of vital knowledge. END

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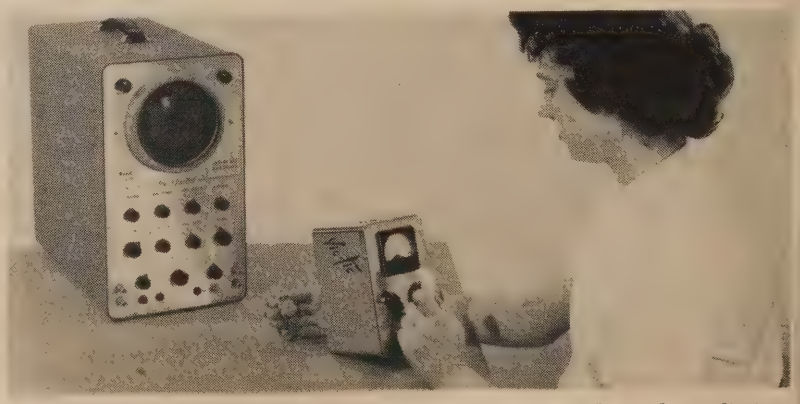
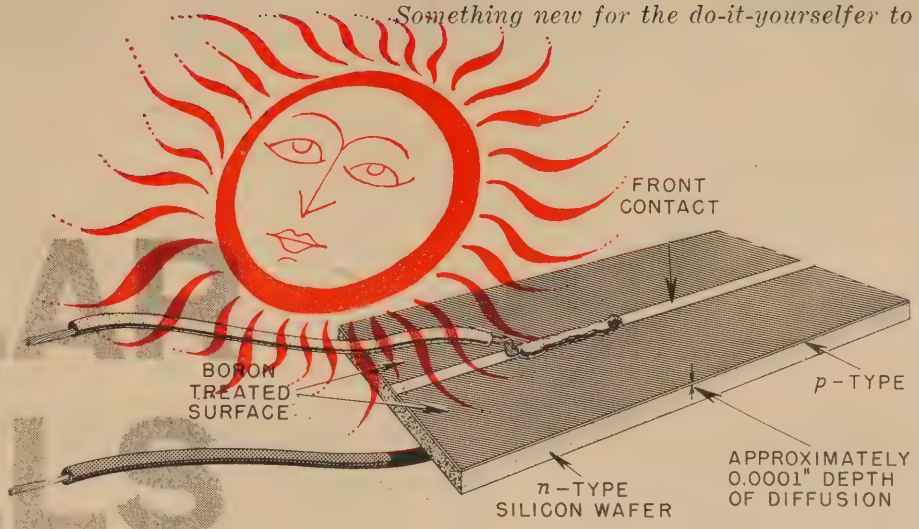


Fig. 8—Using a Geiger counter to measure and hear the radiation given off by the luminous dial of a wrist watch. The oscilloscope is optional and used if a simultaneous visual display is desired.

how to make SOLAR CELLS

Something new for the do-it-yourselfer to try



Makeup of finished home-made solar cell.

By D. M. CHAPIN*

SINCE the silicon solar cell (Bell solar battery) was announced in April, 1954, there has been keen interest in making and using solar cells. Unfortunately, the process was exacting, and required materials and equipment not available in most high school or college laboratories. Anyone who asked how he could make a solar cell was politely told he would be unable to do so and was advised to buy finished cells.

This situation has always been distasteful to several workers at Bell Laboratories, and when I was asked to lecture to a group of science teachers, I resolved to simplify the process so that anyone could use it in any high school lab. It may still be more practical to buy finished cells, but anyone who can handle hydrofluoric and nitric acids can make a solar cell. Probably its efficiency will be less than 10% (maybe 5% or 6%) but the open-circuit voltage even in dim light can be quite good. With reasonable skill in the operation, the finished cell will be reasonably rugged and have permanent soldered leads.

Since this is a how-to-do-it article, theory will be limited to that necessary to understand what is being done. For complete coverage of theory, the reader is directed to the references at the end of the article. For the present, it is sufficient to know that electric current is generated in a silicon crystal (also germanium and others) when light of the proper wavelength (color) is absorbed at the interface between n-type and p-type regions. The types of silicon are produced by minute amounts of impurities. For our purpose, we will start with n-type silicon wafers and change the surface type by diffusing boron into the surface. The depth of diffusion is so small that light can penetrate to the junction between the diffused layer and the original material and produce an electric current. The cell is completed by making contact to the diffused surface and to the original material. (For more information on the whys of this action, consult the references.)

The outline below gives an overall picture of the process and will be followed by a more detailed description.

1. The silicon wafers, obtainable from International Rectifier Corp., are lap-ground with 280 mesh carborundum.
2. The cells are lightly etched in a mixture of HNO_3 (nitric acid) and HF (hydrofluoric acid).
3. One surface is painted with a solution of boric acid, boric oxide or commercial grade borax.
4. To diffuse the boron into the surface, wafers are heated in air for about 10 minutes at about 1,050°C and cooled to room temperature.
5. The untreated side is again lap-ground with carborundum.
6. The cells are treated with HF to remove oxides.
7. Part of the diffused surface is covered with acid-resisting tape.
8. Exposed surfaces are electroplated in electroless nickel-plating solution. (The formula and summary of the process appear later in the article.)
9. Plated surfaces are tinned with solder, and leads are attached.
10. The edges of the wafer are ground with carborundum.
11. HF and HNO_3 etchant is applied to the edges to complete the separation of p- and n-areas.

The operation in detail

1. As previously stated, this process starts with n-type silicon wafers purchased for the purpose. Maybe some day the amateur can start with sand, but refining silicon and preparing wafers is still "beyond the scope——." International Rectifier Corp., (1521 E. Grand Avenue, El Segundo, Calif.), has supplied wafers for educational purposes to high schools and other institutions at $1.25 per wafer. The quotation was for 20 wafers and may be slightly different for smaller amounts. The wafers are 1 x 2 cm and are designated "solar-grade n-type silicon wafers." Very good cells have been made from them.

Lap-grinding the wafers removes surface stains and provides a good surface for electroplating. Use carborundum powder (about 280 mesh) and water on a flat piece of glass, grinding by hand for a minute or two. Slight pressure of the fingers on their tops is sufficient to move the wafers over the glass and cause grinding. Only the surface to be diffused with boron needs to be lapped at this time. The "back" surface will be treated later.

2. Even a very fine grinding produces strains of its own. These can be removed with acid. The effect desired is a compromise between a roughened surface to take the electroplate and a strain-free surface. Before starting, note that **HF and HNO_3 are dangerous acids and the fumes should not be breathed! HF is particularly dangerous as its effects are not immediately evident but persist with considerable pain for**

(*Continued on page 92*)

*Bell Telephone Laboratories, Murray Hill, N. J.

SUPERIOR'S NEW MODEL 77

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Compare it to any peak-to-peak V. T. V. M. made by any other manufacturer at any price

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AS A DC VOLTMETER: The Model 77 is indispensable in Hi-Fi Amplifier servicing and a must for Black and White and color TV Receiver servicing where circuit loading cannot be tolerated.

AS AN ELECTRONIC OHMMETER: Because of its wide range of measurement leaky capacitors show up glaringly. Because of its sensitivity and low loading, intermittents are easily found, isolated and repaired.

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SPECIFICATIONS

• DC VOLTS — 0 to 3/15/75/150/300/750/1,500 volts at 11 megohms input resistance. • AC VOLTS (RMS) — 0 to 3/15/75/150/300/750/1,500 volts. • AC VOLTS (Peak to Peak) — 0 to 8/40/200/400/800/2,000 volts. • ELECTRONIC OHMMETER — 0 to 1,000 ohms/10,000 ohms/100,000 ohms/1 megohm/10 megohms/100 megohms/1,000 megohms. • DECIBELS — 10 db to + 18 db, + 10 db to + 38 db, + 30 db to + 58 db. All based on 0 db = .006 watts (6 mw) into a 500 ohm line (1.73v). • ZERO CENTER METER — For discriminator alignment with full scale range of 0 to 1.5/7.5/37.5/75/150/375/750 volts at 11 megohms input resistance.

Complete with operating instructions, probe, leads, and case, 110-120 volt 60 cycle. Only..... **$42.50 NET**

Model 77—Vacuum Tube Voltmeter
Total Price $42.50
Terms: $12.50 after 10 day trial, then $6.00 monthly for 5 months if satisfactory. Otherwise return, no explanation necessary.

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VOLT-OHM MILLIAMMETER.

Plus **CAPACITY, REACTANCE, INDUCTANCE and DECIBEL MEASUREMENTS.**

Also Tests **SELENIUM and SILICON RECTIFIERS, SILICON and GERMANIUM DIODES.**

The Model 79 represents 20 years of continuous experience in the design and production of SUPER-METERS, an exclusive SICO development.

In 1938 Superior Instruments Co. designed its first SUPER-METER, Model 1150. In 1940 it followed with Model 1250 and in succeeding years with others including Models 670 and 670-A. All were basically V.O.M.'s with extra services provided to meet changing requirements.

Now, Model 79, the latest SUPER-METER includes not only every circuit improvement perfected in 20 years of specialization, but in addition includes those services which are "musts" for properly servicing the ever increasing number of new components used in all phases of today's electronic production. For example with the Model 79 SUPER-METER you can measure the quality of selenium and silicon rectifiers and all types of diodes—components which have come into common use only within the past five years, and because this latest SUPER-METER necessarily required extra meter scale, SICO used its new full-view 6-inch meter.

Specifications

D.C. VOLTS: 0 to 7.5/15/75/150/750/1,500.
A.C. VOLTS: 0 to 15/30/150/300/1,500/3,000.
D.C. CURRENT: 0 to 1.5/15/150 Ma. 0 to 1.5/15 Amperes.
RESISTANCE: 0 to 1,000/100,000 Ohms. 0 to 10 Megohms.
CAPACITY: .001 to 1 Mfd. 1 to 50 Mfd.
REACTANCE: 50 to 2,500 Ohms, 2,500 Ohms to 2.5 Megohms.
INDUCTANCE: .15 to 7 Henries, 7 to 7,000 Henries.
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The following components are all tested for QUALITY at appropriate test potentials. Two separate BAD-GOOD scales on the meter are used for direct readings.

All Electrolytic Condensers from 1 MFD to 1000 MFD.
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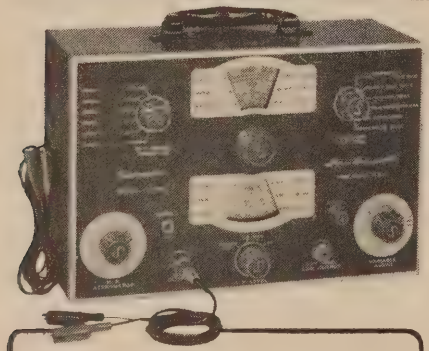

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A versatile all-inclusive GENERATOR which provides ALL the outputs for servicing:

A.M. Radio • F.M. Radio • Amplifiers • Black and White TV • Color TV

R. F. SIGNAL GENERATOR: The Model TV-50A Genometer provides complete coverage for A.M. and F.M. alignment. Generates Radio Frequencies from 100 Kilocycles to 60 Megacycles on fundamentals and from 60 Megacycles to 180 Megacycles on powerful harmonics.

VARIABLE AUDIO FREQUENCY GENERATOR: In addition to a fixed 400 cycle sine-wave audio, the Model TV-50A Genometer provides a variable 300 cycle to 20,000 cycle peak wave audio signal.

BAR GENERATOR: The Model TV-50A projects an actual Bar Pattern on any TV Receiver Screen. Pattern will consist of 4 to 16 horizontal bars or 7 to 20 vertical bars.

CROSS HATCH GENERATOR: The Model TV-50A Genometer will project a cross-hatch pattern on any TV picture tube. The pattern will consist of non-shifting, horizontal and vertical lines interlaced to provide a stable cross-hatch effect.

DOT PATTERN GENERATOR (FOR COLOR TV) Although you will be able to use most of your regular standard equipment for servicing Color TV, the one addition which is a "must" is a Dot Pattern Generator. The Dot Pattern projected on any color TV Receiver tube by the Model TV-50A will enable you to adjust for proper color convergence.

MARKER GENERATOR: The Model TV-50A includes all the most frequently needed marker points. The following markers are provided: 189 Kc., 262.5 Kc., 456 Kc., 600 Kc., 1000 Kc., 1400 Kc., 1600 Kc., 2000 Kc., 2500 Kc., 3579 Kc., 4.5 Mc., 5 Mc., 10.7 Mc. (3579 Kc. is the color burst frequency).

THE MODEL TV-50A comes absolutely complete with shielded leads and operating instructions.

$47.50 NET

Model TV-50A—Genometer. Total price—$47.50—Terms: $11.50 after 10 day trial, then $6.00 monthly for 6 months if satisfactory. Otherwise return, no explanation necessary!

EXAMINE BEFORE YOU BUY!

USE APPROVAL FORM ON NEXT PAGE

SUPERIOR'S NEW MODEL TW-11

STANDARD PROFESSIONAL TUBE TESTER

★ Tests all tubes, including 4, 5, 6, 7, Octal, Lock-in, Hearing Aid, Thyratron, Miniatures, Sub-miniatures, Novals, Subminars, Proximity fuse types, etc.
★ Uses the new self-cleaning Lever Action Switches for individual element testing. Because all elements are numbered according to pin-number in the RMA base numbering system, the user can instantly identify which element is under test. Tubes having tapped filaments and tubes with filaments terminating in more than one pin are truly tested with the Model TW-11 as any of the pins may be placed in the neutral position when necessary.
★ The Model TW-11 does not use any combination type sockets. Instead individual sockets are used for each type of tube. Thus it is impossible to damage a tube by inserting it in the wrong socket.
★ Free-moving built-in roll chart provides complete data for all tubes. All tube listings printed in large easy-to-read type.

NOISE TEST: Phono-jack on front panel for plugging in either phones or external amplifier will detect microphonic tubes or noise due to faulty elements and loose internal connections.

EXTRAORDINARY FEATURE

SEPARATE SCALE FOR LOW-CURRENT TUBES: Previously, on emission-type tube testers, it has been standard practice to use one scale for all tubes. As a result, the calibration for low-current types has been restricted to a small portion of the scale. The extra scale used here greatly simplifies testing of low-current types.

Model TW-11—Tube Tester
Total Price $47.50
Terms: $11.50 after 10 day trial, then $6.00 monthly for 6 months if satisfactory. Otherwise return, no explanation necessary.

The Model TW-11 operates on 105-130 Volt 60 Cycles A.C. Comes housed in a handsome portable saddle-stitched Texon Case. Only **$47.50**

SUPERIOR'S NEW MODEL 82A

Multi-Socket Type TUBE TESTER

TEST ANY TUBE IN 10 SECONDS FLAT!

1. Turn the filament selector switch to position specified.
2. Insert tube into a numbered socket as designated on our chart (over 600 types included).
3. Press down the quality button—

THAT'S ALL! *Read emission quality direct on bad-good meter scale.*

SPECIFICATIONS

- Tests over 600 tube types
- Tests OZ4 and other gas-filled tubes
- Employs new 4" meter with sealed air-damping chamber resulting in accurate vibrationless readings
- Use of 22 sockets permits testing all popular tube types and prevents possible obsolescence
- Dual Scale meter permits testing of low current tubes
- 7 and 9 pin straighteners mounted on panel
- All sections of multi-element tubes tested simultaneously
  Ultra-sensitive leakage test circuit will indicate leakage up to 5 megohms

Production of this Model was delayed a full year pending careful study by Superior's engineering staff of this new method of testing tubes. Don't let the low price mislead you! We claim Model 82A will outperform similar looking units which sell for much more — and as proof, we offer to ship it on our examine before you buy policy.

To test any tube, you simply insert it into a numbered socket as designated, turn the filament switch and press down the quality switch — THAT'S ALL!. Read quality on meter. Inter-element leakage if any indicates automatically.

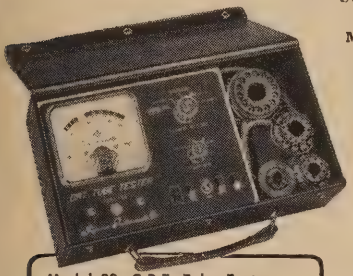
Model 82A—Tube Tester
Total Price $36.50
Terms: $6.50 after 10 day trial, then $6.00 monthly for 5 months if satisfactory. Otherwise return, no explanation necessary.

Model 82A comes housed in handsome, portable Saddle-Stitched Texon case. Only .. **$36.50**

SUPERIOR'S NEW MODEL 83

C.R.T. TESTER

TESTS AND REJUVENATES ALL PICTURE TUBES



ALL BLACK AND WHITE TUBES

From 50 degree to 110 degree types —from 8" to 30" types.

- Model 83 is not simply a rehashed black and white C.R.T. Tester with a color adapter added. Model 83 employs a new improved circuit designed specifically to test the older type black and white tubes, the newer type black and white tubes and all color picture tubes.
- Model 83 provides separate filament operating voltages for the older 6.3 types and the newer 8.4 types.
- Model 83 employs a 4" air-damped meter with quality and calibrated scales.
- Model 83 properly tests the red, green and blue sections of color tubes individually—for each section of a color tube contains its own filament, plate, grid and cathode.

ALL COLOR TUBES

Test ALL picture tubes—in the carton—out of the carton—in the set!

- Model 83 will detect tubes which are apparently good but require rejuvenation. Such tubes will provide a picture seemingly good but lacking in proper definition, contrast and focus. To test for such malfunction, you simply press the rej. switch of Model 83. If the tube is weakening, the meter reading will indicate the condition.
- Rejuvenation of picture tubes is not simply a matter of applying a high voltage to the filament. Such voltages improperly applied can strip the cathode of the oxide coating essential for proper emission. The Model 83 applies a selective low voltage uniformly to assure increased life with no danger of cathode damage.

Model 83—C.R.T. Tube Tester
Total Price $38.50
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Model 83 comes housed in handsome portable Saddle Stitched Texon case—complete with sockets for all black and white tubes and all color tubes. Only.. .. **$38.50**

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Try any of the instruments on this or the facing page for 10 days before you buy. If completely satisfied then send down payment and pay balance as indicated on coupon. No Interest or Finance Charges Added! If not completely satisfied return unit to us, no explanation necessary.

MOSS ELECTRONIC, INC.
Dept. D-729, 3849 Tenth Ave., New York 34, N. Y.

Please send me the units checked on approval. If completely satisfied I will pay on the terms specified with no interest or finance charges added. Otherwise, I will return after a 10 day trial positively cancelling all further obligations.

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- ☐ Model TV-50A.....Total Price $47.50 $11.50 within 10 days. Balance $6.00 monthly for 6 months.
- ☐ Model TW-11.....Total Price $47.50 $11.50 within 10 days. Balance $6.00 monthly for 6 months.
- ☐ Model 82A.....Total Price $36.50 $6.50 within 10 days. Balance $6.00 monthly for 5 months.
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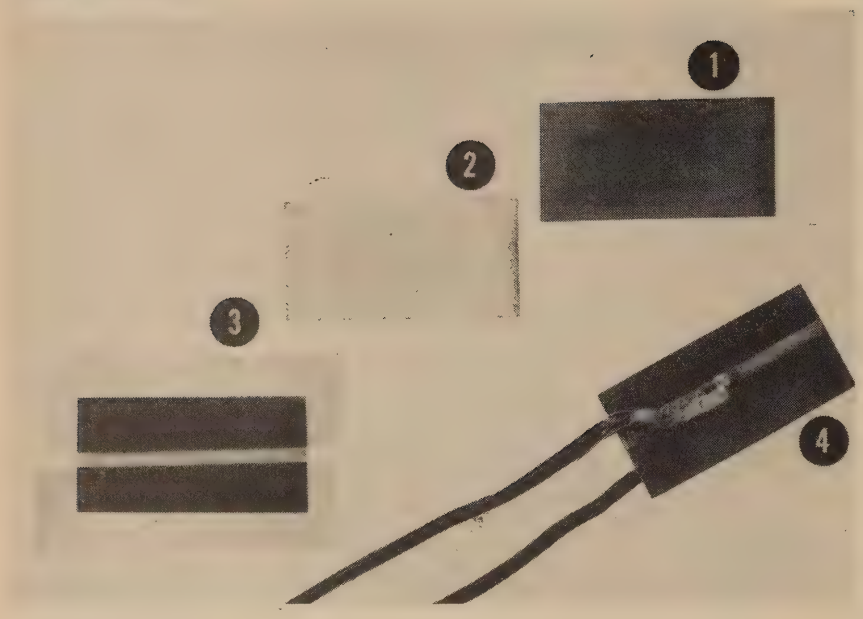


The solar cell at various stages: (1) the raw silicon element; (2) after diffusion —step 4; (3) after plating— step 8; (4) the completed unit.

(*Continued from page* 89)

hours or days. The area around the nails is especially vulnerable. Rubber gloves or careful handling with frequent washing in fresh water is necessary. A slurry of MgO in glycerine should be applied immediately to any suspected areas of contact. A fume hood is desirable, but careful handling in a well ventilated room proved quite satisfactory in a recent demonstration. Be sure you know how to handle acids before attempting this process.

In one respect these acids are easy to handle. Concentrated HNO_3 and HF can be mixed freely in any proportion with each other and with water without danger of overheating and violent eruption.

Plastic trays cut from empty HF bottles make excellent containers for etching. Glass and metal containers will be attacked by the acids. Cover the wafer to be etched with concentrated HNO_3. Add small amounts of concentrated HF, stirring by tipping the tray until bubbles start. Action can be stopped by flooding with HNO_3. After about ½ minute of etching, flood with HNO_3, pour off the acids and rinse several times with pure water. A shiny surface indicates too much etching, which will give a good p-n layer but will make attaching contacts very difficult.

3. Almost any compound of boron appears to be effective, and several solvents, including water and alcohol, have been used in related processes. The particular combination used in the present process was boric acid and methyl-cellosolve. To this was added fine alundum powder which acts as a binder, prevents sticking if several wafers are stacked, and serves to identify the treated surface. It is not essential to the process.

The proportions of this mixture are not critical. I used about equal parts of boric acid and alundum powder with enough methyl-cellosolve to make a thin paste.

Paint the mixture on the lapped surface of the wafer. Drying of the surface is desirable, although it appears not essential. Alundum containers or fragments of quartz tubing make good holders for the wafers.

4. Almost any ceramic oven, stove or furnace will reach 1,050°C.

A temperature of 1,100°C gives faster diffusion. However, the best cells made recently were heated only to 1,000°C. For these, the time was increased to a half hour. Cells have been made at 950°C.

Diffusion in air has been shown to be quite satisfactory. There may be some virtue in protecting against contamination from the furnace by enclosing the wafer in a quartz tube open at one or both ends. In a recent demonstration, the simplest furnace imaginable was used. The photo shows the parts for such a furnace and an assembled furnace. The heating element is an Eagle straight Glocoil No. 415 made by Eagle Electric Manufacturing Co. and is available in many hardware stores. The hole in the center of the ceramic core serves as a heating chamber. The coil is mounted horizontally in a hole bored through a magnesia brick. A few pieces of firebrick around the coil would serve almost as well. Even moderately insulated, this unit will get too hot and burn out on normal house voltage. A Variac (variable autotransformer) to control the temperature is very useful. A bank of ordinary lamps in series with the furnace can be used as a rheostat to control the power to the furnace. To increase furnace temperature, use more lamps or higher wattage ones. Lacking these, temperature can be controlled by moving the brick insulation away from the heater coil.

Too long a diffusion time at high temperature will give a barrier beyond the reach of incoming light and will produce a cell of low current. Too little diffusion gives a surface easily damaged, a p-n junction too near the surface to absorb radiation and too high a surface resistance. Both voltage and current will be degraded.

At the end of the heating period (about 10 minutes for 1,050°C, 30 minutes for 1,000°C), remove the wafer in its quartz boat and let it cool rapidly in air. You now have a p-n barrier near the top surface. The remaining steps are to clean it up and to make appropriate contacts.

5. The untreated side is again lap-ground with carborundum. The treated side has a coating of oxide on it and is not easily damaged at this point. The grinding is to remove any p-type layer from the back surface and expose clean n-type material. It is done in the same manner as before.

6. In the polyethylene tray, cover the wafer with HF and let stand for a minute or two. HF will remove the oxide but not damage the silicon. Be sure that all traces of HNO_3 have been removed or the p-layer will be etched off. There should not be any visible evidence of chemical action except that the alundum powder will wash off the treated surface. Rinse carefully in clean water and handle only with filter paper. At this stage, keep fingers off!

7. A good acid-resisting tape is Minnesota Mining & Manufacturing Co. tape No. 549. Cut two strips of this tape and press on the active surface, leaving a narrow strip 1/16 inch wide down the center. Press the tape down well

to insure bonding. A little tape extending beyond the end and edges is useful for handling without touching the wafer.

8. Put the wafer in electroless (see formula and summary of process below) nickel-plating solution heated to just below boiling. Cover the container to keep out light. Without this precaution, voltages formed by the barrier prevent proper plating to the p-layer. About 10 minutes in the solution gives a good coverage. When the cell comes out of this bath, it should have a mat silver coating on the narrow strip and on the back. The coating should be tightly bonded and not easily rubbed off. Rinse well with water.

Electroplating is largely an art. If you did not get a well bonded electroplate, try putting in a little more ammonia. Sometimes it appears to help to drop in a small piece of freshly polished silicon or metal as a starter. If the electroplate peels off the top surface, maybe the cell was dirty from handling or perhaps the cell was etched too much in step **2**. Either start all over or skip step **9** and be satisfied with pressure contacts and low current. A good voltage should result on open circuit and this will be reassuring and show that the diffusion was done correctly.

9. Remove the masking tape and tin all plated surfaces with a good grade of acid core solder (or radio solder with acid paste). Acid flux is useful here and should give a well tinned surface. Be a little careful on the treated surface not to scratch through the p-n layer. Solder flexible copper leads to top and bottom, staying away from the extreme edges to facilitate step **11**. Rinse off all acid flux. You now should have a good cell with firmly soldered leads but completely self-shorted.

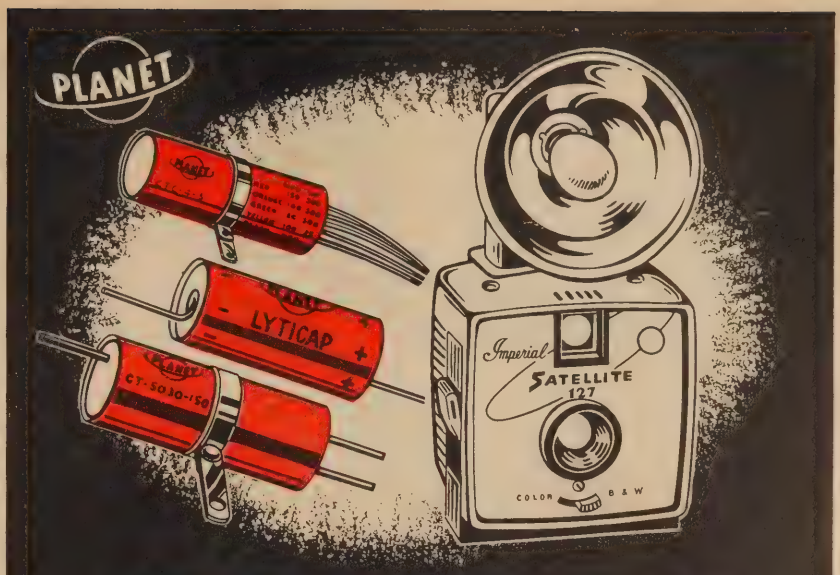
10. Grind edges all around to separate the top surface from the bottom electrodes. Use carborundum powder on glass as before. Rinse and dry well.

11. Mix a small amount of equal parts of HF and HNO_3. Holding the cell by its leads and using a splinter of wood (for example, a large toothpick), paint the acid mixture on all the edges. This provides a separation not possible with grinding alone. After a minute or two, wash well in a flood of water to prevent etching where not wanted. If it is necessary to repeat this etch, be sure to dry the cell well before painting on more acid.

Recently, solar cells have been made omitting steps **2** and **11** (etching with acids). The results were satisfactory. So the beginner is urged to eliminate these steps for his first cell. If someone then finds a simpler method to remove the oxide formed during the diffusion (step **6**), both the HNO_3 and HF can be eliminated and the process will be quite safe.

Testing the cell

Do not expect a 10% cell from this process, although you may approach



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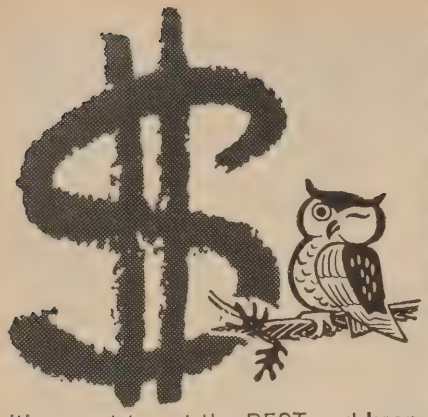

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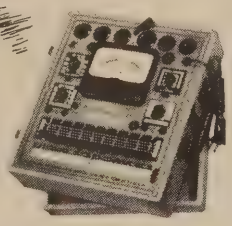
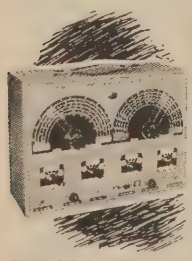
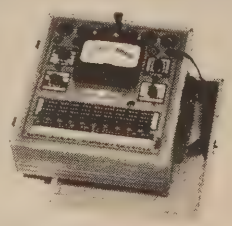
Model 102 Volometer
Features a 3½", 2% accurate—800 microamperes D'arsonval-type plastic front meter with 3 AC current ranges; and the same zero adjustment for both resistance ranges. Specifications . . . AC Voltage—5 Ranges: 0 to 12-120-600-1200-3000 volts. DC Voltage—5 Ranges: 0 to 6-60-300-600-3000 volts. AC Current—3 Ranges: 0 to 30-150-600 ma. DC Current—4 Ranges: 0 to 6-30-130 ma. 0 to 1.2 amps. Two Resistance Ranges: 0 to 1000 ohms, 0 to 1 megohms. **Model 102**, Wt. 1 lb. 5 oz. Size: 3¾" x 6¼" x 2". **$14.90**; Kit, **$12.50.**



Model 204 Tube-Battery-Ohm Capacity Tester
Emission tube tester. Completely flexible switching arrangement. Checks batteries under rated load on "reject-good" scale. Checks condenser leakage to 1 meg. Checks resistance up to 4 megs. Checks capacity from .01 to 1 mfd. **Model 204P**, illustrated. **$55.90. Model CRA**, Cathode ray tube adaptor, **$4.50.**



Model 700 RF-AF Crystal Marker TV Bar-Generator
Complete coverage from 18 cycles to 108 megacycles on fundamentals. Bar generator for TV adjustment with a variable number of bars available for horizontal or vertical alignment. Square wave generator to 20 kilocycles. Wien Bridge AF oscillator with sine wave output from 18 cycles to 300 kilocycles. Crystal marker and amplitude control. Individually tuned coils. Constant RF output impedance. Stepped RF attenuator. Variable percentage of modulation. **Model 700** **$55.90**



Model 205 Tube Tester
Uses standard emission test. Tests all tubes including Noval and subminiatures. Completely flexible switching arrangement. Checks for shorts, leakages and opens **Model 205P**, Hand rubbed oak carrying case, **$47.50** (illustrated); Kit, **$36.20. Model CRA**, Cathode ray tube adaptor, **$4.50.**

Model 104 Volometer
Features a 4½", 50 microampere meter, with 3 AC current ranges and 3 resistance ranges to 20 megohms. Specifications . . . DC Voltage: 5 ranges (20,000 ohms per volt): 0 to 6-60-300-600-3000 volts. AC Voltage: 5 ranges (1,000 ohms per volt). 0 to 6-60-300-600-3000 volts. DC Current—3 Ranges: 0 to 6-60-600 ma. AC Current—3 Ranges: 0 to 30-300 ma. 0 to 3 amps. 3 Resistance Ranges. 0 to 20K, 0 to 200K, 0 to 20 megs. 5 DB Ranges: —4 to +67 DB. **Model 104**, with carrying strap. Wt. 2 lbs. 5 oz. Size: 5¼" x 6¾" x 2½". **$26.95;** Kit, **$19.95. Model HVT**, 30,000 volt probe for Model 104, **$7.95.**

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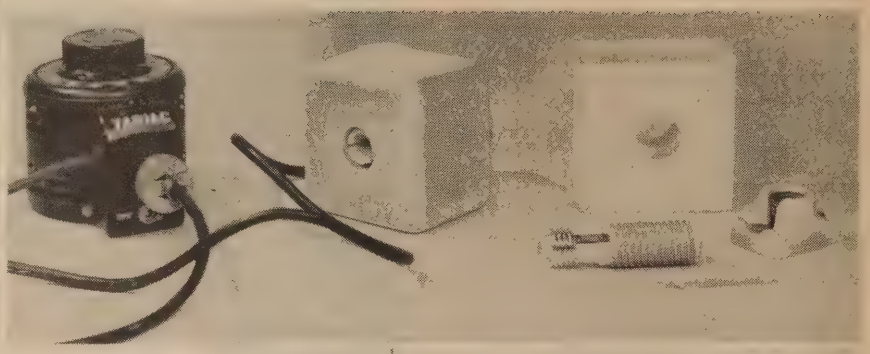
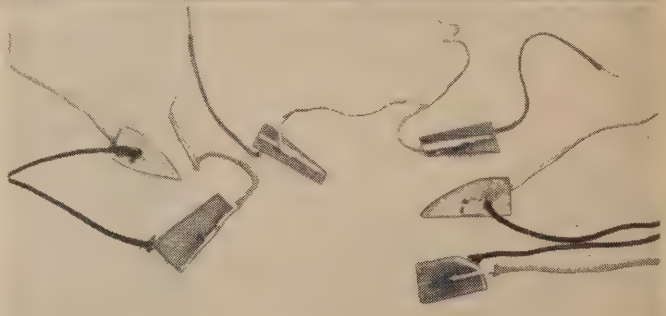


(Above) Simple furnace is made from magnesia brick and a standard heating element.



(Right) Assortment of home-made solar cells.

this value. You can get a good idea of how well you have done by the following rough tests. The treated surface will be the positive terminal. In a well lighted room but not in direct sunlight nor directly under a lamp, a reading of 0.3 volt on a good voltmeter is good, 0.2 volt is acceptable and anything near 0.4 volt is excellent. A good reading here indicates that your barrier is good and that the cell is not shorted. If you get much less than 0.2 volt under this condition, try etching the edges again, or maybe repeat both grinding and etching.

Now increase the light to full sunlight or what can be obtained close to a 100-watt lamp. Before the cell gets hot, a reading of 0.50 volt is good, 0.40 volt is passable and 0.55 volt puts you with the experts.

The voltage test tells if the barrier is good and not shorted. Now connect to an ammeter to test the contacts and the depth of the barrier. Under a strong spotlight, current up to 0.2 ampere is possible. In full sunlight .030 ampere short-circuit is good and .040 is excellent. The theoretical limit for 1 x 2-cm wafers is about .090 ampere in full sunlight.

Cells can be connected in series to produce more voltage or in parallel to increase the current. In planning your finished battery, allow about 0.3 volt per cell for best power output.

Formula for electroless nickel

1. Nickel chloride—30 grams
2. Sodium hypophosphite—10 grams
3. Ammonium citrate—65 grams
4. Ammonium chloride—50 grams

Add water to make 1,000 cc. Filter the solution. Add ammonium hydroxide (household ammonia) until the solution turns from green to blue. The pH should be between 8 and 10. Bring the solution to just under boiling and drop in the parts to be plated. Ten minutes is normal plating time. Plate light-sensitive material in the dark. Keep surfaces free from grease. Do not handle surfaces to be plated. END.

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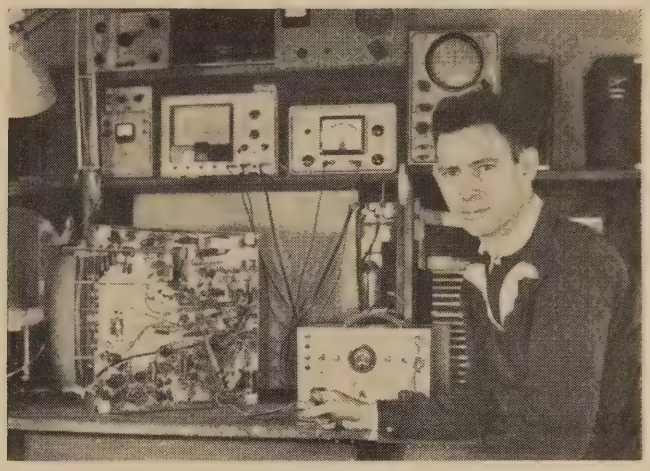
LICKING THE i-n-t-e-r-m-i-t-t-e-n-t-s

Techniques for tracking down these most difficult of troubles



Technician using the surge supply for testing intermittent in a television receiver.

By LYMAN E. GREENLEE

INTERMITTENTS! Please, don't mention that nasty word around the shop. They may make life interesting for the technician but they certainly do not add to his income unless he is equipped to handle them with speed, and too many of such time-consuming toughies can put a technician out of the service business for good.

One cannot delve into a tough electronic mystery with only bare hands and horse sense. These things help, but good equipment is also required. Unfortunately, many technicians are limited as to funds for purchase of all the equipment they may need. The equipment essential for working with intermittents with any degree of success is:

Tube checker While a mutual conductance checker is preferred, a simple emission job is useful and costs less. Since the best tester we can buy will not reveal some tube defects and we must as a last resort try substitution, most any simple checker will do. For field service, its speed of operation, ruggedness and portability are the most important considerations.

Volt-ohm-milliammeter This instrument should be accurate, portable, rugged and dependable. Many good ones are now on the market at reasonable prices.

Variable-voltage isolation transformer This piece of equipment should vary the line voltage between 0–150 volts. The transformer should handle at least 7.5 amps continuously. If a voltmeter is not built in, provide one externally for monitoring the output.

Vacuum-tube voltmeter

Oscilloscope

Signal generator One that will cover the operating frequencies of the equipment under test. For most checking on intermittents, tests are made using the regular channels rather than the output from the signal generator.

Source of variable dc voltage For making surge tests and breakdown tests on capacitors, resistors and transformers. This piece of equipment (see "Surge Supply for Intermittents," December, 1956, page 58) can be made out of junkbox parts.

Resistance–capacitance bridge This piece of equipment is highly recommended because of the excellent leakage checks provided that will reveal hidden sources of trouble. Since capacitors are among the worst offenders when it comes to causing intermittent operation, checking them accurately is important. And to avoid trouble with repair jobs, *every* replacement should be carefully checked before it is put into use.

Heat lamp This unit should be portable and have an aluminum reflector.

A heat bulb may be inserted in a photographic reflector equipped with a hand clamp. The lamp is used to raise the working temperature of suspected parts. Heat must always be applied carefully to avoid damage.

Hot box for cooking a chassis The box is simply four pieces of plywood ⅜ inch thick and about 30 inches square. It can be assembled over the chassis to form a box with the bottom and front open. The boards may be held together with small pieces of angle iron and some wood screws so that the assembly may be dismantled and folded flat for easy storage when not in use. The plywood should be covered on one side with sheet asbestos which may be attached with ordinary wallpaper paste. Cover the front with a piece of canvas or an old blanket. Mount a thermometer through a hole in the top board to show the inside temperature and you are ready for business. Because of fire hazard, a chassis must be watched constantly while cooking. Always keep a fire extinguisher handy.

A bar generator, audio oscillator, grid dip meter, resistance and capacitance substitution boxes, picture-tube reactivator and checker, and a signal tracer are all useful in checking intermittents. Several potentiometers mounted on a board with test leads attached are also useful. Equipment built from kits is adequate for most jobs. The saving in cost is certainly worth while.

A large percentage of service calls involve only tube replacement. Ordinary tube troubles like shorts, open filaments or heaters, weak emission, gas and breakage show up immediately.

(*Continued on page* 100)

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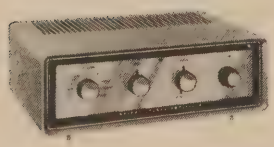

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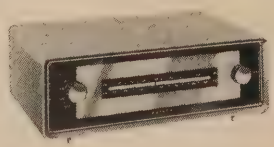

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Model Y-712D. Superhet Transceiver Kit. **$5 DOWN**

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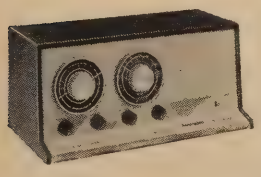

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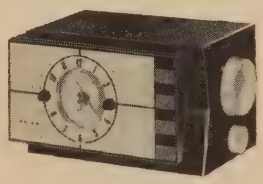

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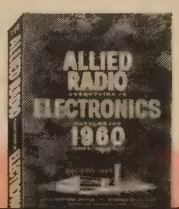

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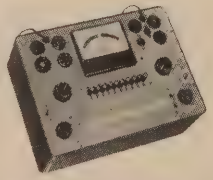

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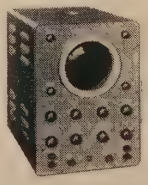

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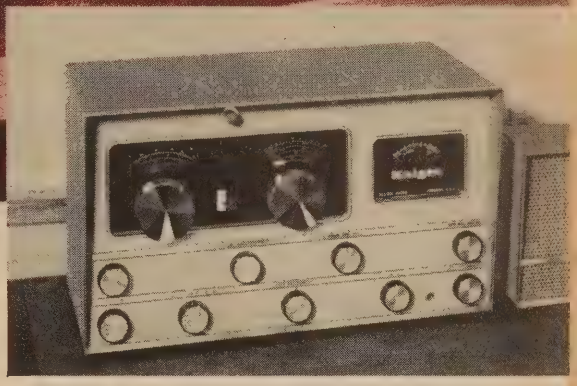

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Truly the "dream" transmitter—has what it takes to punch out a QRM-busting SSB, AM, or CW signal. 600 watts P.E.P. input on SSB; 400 watts on AM and CW. Covers 80, 40, 20, 10, and 15 or 6 meter bands. Start with the basic CW kit— then add AM and SSB accessory units and other "add-ins" whenever you wish. Has heterodyne VFO to assure a signal which "stays put." Tremendous 14" dial is precision-calibrated for all bands, 80 through 6 meters. SSB features: front panel controls—VOX, anti-trip and adjustable speech compression. Smooth, chirpless screen-clamp keying, plus VFO keying for complete CW break-in. Has 7034/4X150A final—coasts along well within its CCS ratings; silicon rectifier power supply runs cool. Dozens of advanced features put this job in a class all its own. Shpg. wt. 140 lbs.

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Model Y-716D. T-400 CW Transmitter Kit.

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Y-726D
$104.50
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Incomparable receiver kit with all the features, selectivity and sensitivity of high-priced commercial units. Tunes 540 kc to 30 mc in 4 bands; calibrated bandspread on all Ham bands; 300 cps to 4.5 kc selectivity; exclusive printed-circuit bandswitch; built-in Q-multiplier; constant-running HFO—dozens of other professional features. Truly superior kit value. 30 lbs.

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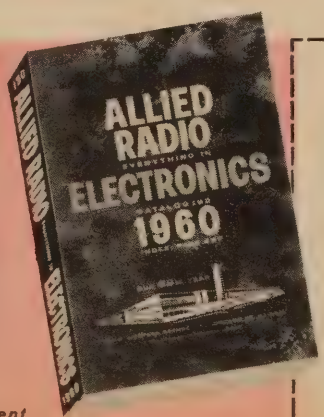

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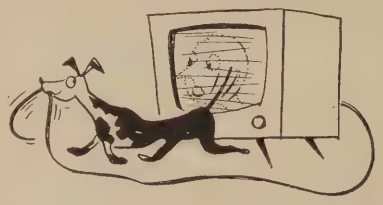
GS-400 FEATURES — *4-speed automatic and manual operation: 16, 33, 45, 78 rpm • rumble, wow and flutter virtually inaudible • counter balanced, die-cast aluminum arm • damped acoustically isolated arm—shock suspension prevents mechanical feedback through arm pivot. Resonance is negligible • 4-pole, hum-shielded motor for smooth constant speed • full provision for 2, 3, or 4 terminal, stereo and mono cartridges • single-knob control sets all operations • double-channel muting switch and RC network maintains silence for both stereo channels • quick-change cartridge holder.*

TELEVISION

(*Continued from page* 95)

The old tubes are thrown away and new ones installed—the customer is happy. The fun starts when the customer calls 2 hours later to inform us that we did not fix her set, we just made it worse. By the time we get back to look the situation over, everything is working like a charm. We turn the set off and it refuses to come back on again. That's the way it goes!

Often a new rectifier tube will pep up plate voltages enough to cause a coupling capacitor to let go, and once the cycle has started there is no cure short of actually tracking down the defective part and replacing it. Meanwhile, the owner is unhappy about the whole deal and often unwilling to pay for any



extra labor or materials. Tact and a lot of careful explaining are necessary at this point, and here is where knowledge, experience and equipment will pay off.

The set is taken to the shop, and the tubes check OK. But are they really all good? No tube checker can give a final answer because there are some defects that do not show up on the best of tube checkers. The applied voltages and loads are different from those in the chassis. Pounding on the tubes while they are being checked often indicates loose elements; it can also break good tubes. And we may still overlook an intermittent. The fastest way to eliminate tubes completely as a source of trouble is to replace the whole set at one time, and then give the equipment a thorough check. If the trouble shows up after the usual waiting time, we can forget about tubes and start looking elsewhere.

A complete set of good used tubes should be kept on a rack above the workbench for use in checking doubtful sets. These tubes should be set-tested and all above reproach as far as noise, emission and overall performance can be determined. A very important point to remember when working with intermittents is: *never do anything haphazardly.* Always keep a record of every move so things can always be returned to the starting point in case the trouble has not been found.

External causes of trouble

Before pulling a chassis make sure that the trouble is not external. Many hours have been wasted slaving over a perfectly good chassis only to find later on that it was the antenna that was bad or the line voltage was way off. This check list may help to eliminate the external causes of trouble:

Antenna system

1. Check for loose elements, corrosion,

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TRANSMITTER similar to above but with 5 watt RF stage instead of 1 watt. $14.99 each, two for $15.00.

CITIZENS BAND RECEIVER chassis turnable through all 22 channels. Complete with audio amplifier. $9.99 ea., two for $10.00.

AMATEUR BAND TRANSCEIVER (144-148 MC) chassis with dual VHF triodes for walkie-talkie radiophone. $9.99 ea., two for $10.00.

TRANSCEIVER TRANSFORMER: Mike to grid input and plate to low impedance headphone output. Good for telephone handsets. $1.99 pair, two for $2.00.

TELEPHONE HANDSETS with push-to-talk switch. $5.99 each, two pair for $6.00.

MICROPHONE High output 200 ohm carbon with terminal lugs. $1.49 ea., two for $1.50.

COILED CORD 4 conductor 11" telephone cord. Extends to over 4 ft. .99 ea., two for $1.

KIT OF PARTS for AM-FM VHF radio receiver. Tunable from 80-200 mc. which includes U. S. satellite frequencies. $6.99 ea., two for $7.00.

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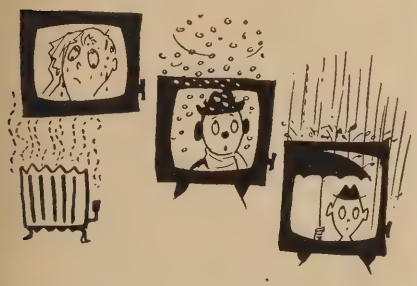
broken or spliced lead-in, broken insulators and leakage due to dampness.
2. Check the ground wire, lightning arrester and the antenna rotor.
3. Always check field strength if possible and, as a last resort when tracing intermittent interference, substitute another set in the same location.
4. Check switches, converters or boosters in the antenna circuit.

Input power

1. Check the line cord, plug and house wiring.
2. Check for low or high voltage. A recording voltmeter (usually supplied by the local power and light company) indicates excessive variations if left on the line for 24 hours. A consistently high or low voltage can be corrected at the transformer by altering taps; this work must be done by the utility maintenance crew. They are usually very cooperative and glad to be of service in correcting difficulties of this type.

Temperature

1. May be excessive due to inadequate ventilation. Check for heavy drapes which impede air circulation, or



chassis located over heat register. Check for excess heat or poor ventilation from any cause.
2. Low temperature may be a factor if set is operated in an unheated room such as a warehouse in winter.
3. Removing chassis from cabinet alters the temperature characteristics and may make location of the intermittent extremely difficult or impossible. Use the hot box for checking to make sure excessive heat is not the cause of trouble.

Humidity

Check for excessive dampness. A laundry or kitchen location may be one of high humidity, and such a condition can produce arcing, leakage and shorts.

Animals and insects

1. If there is a pup around, make sure it does not chew the lead-in or pull the line cord from the wall socket.
2. Mice or rats have been known to clip wires and create a bad corrosion problem which may damage tuning capacitors and other parts, creating a miscellaneous assortment of potential trouble spots.

(*Continued on page* 104)

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No longer do you have to cart around a maze of entangled cables, lose time alternating cables or hunting for a misplaced probe. With just a twist of the MULTI-PROBE tip you can set it to function as either a DC Probe, AC-Ohms Probe, Lo-Cap Probe or RF Probe.

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BATTERY OPERATED
Completely portable . . . Invaluable wherever line connection is undesirable or unavailable . . . Unique circuitry assures low battery drain.

Model VT-10 **$58.50 Net**
TERMS: $14.50 within 10 days. Balance $11 monthly for 4 months.

Model VT-1 **$58.50 Net**
TERMS: $14.50 within days. Balance $ monthly for 4 months.

FUNCTIONS OF VT-1 and VT-10

DC VOLTMETER . . . Will measure D.C. down to 1.5 volts full scale with minimum circuit loading, and give accurate readings of scale divisions as low as .025 volts . . . Will measure low AGC and oscillator bias voltages from .1 volts or less up to 1500 volts with consistent laboratory accuracy on all ranges . . . Zero center provided for all balancing measurements such as discriminator, ratio detector alignment and hi-fi amplifier balancing.

AC VOLTMETER . . . True Peak-to-Peak measurements as low as 3 volts of any wave form including TV sync, deflection voltages, video pulses, distortion in hi-fi amplifiers, AGC and color TV gating pulses . . . Scale divisions are easily read down to .1 volts . . . Measures RMS at 1/20th the circuit loading of a V.O.M. . . . Unlike most other V.T.V.M.'s there is no loss in accuracy on the lowest AC range.

ELECTRONIC OHMETER . . . Measures from 0 to 1000 megohms . . . Scale divisions are easily read down to .2 ohms . . . Will measure resistance values from .2 ohms to one billion ohms . . . Will detect high resistance leakage in electrolytic and by-pass condensers.

RF and LO-CAP MEASUREMENTS . . . With these extra VT-1 functions you can measure voltages in extremely high-impedance circuits such as sync and AGC pulses, driving saw tooth voltages, color TV gating pulses, mixer output levels, I.F. stage-by-stage gain and detector inputs.

FEATURES OF VT-1 and VT-10

- New advanced pentode amplifier circuit
- Large 6" 100-microampere meter, many times more sensitive than meters used in most V.T.V.M.s
- Simplified multi-color easy-to-read 4-scale meter
- No heat operation assures stability and accuracy
- Amplifier rectifier circuit with frequency compensated attenuator — a feature found only in costly laboratory instruments
- Meter completely isolated
- Hand-crafted circuitry eliminates the headaches of printed circuitry
- 1% resistors used for permanent accuracy
- Rugged gray hammertone steel case provides necessary shielding and eliminates plastic case drawbacks of cracking or melting
- Deep brushed long lasting etched aluminum panel
- Matching cover protects instrument face — snaps on and off instantly.

SPECIFICATIONS OF VT-1 and VT

- **DC Volts** — 0 to 1.5/6/30/150/300/6 1500 volts
- **AC Volts (RMS and Peak-to-Peak)** — 3/12/60/300/1200 volts
- **Ohms** — to a billion ohms, 10 ohms ter scale — RX1/10/100/1K/10K/100 1M
- **RF** — Peak reading demodulator s plied for use on all DC ranges
- **Zero Center** — available on all DC ranges with zero at mid-scale
- **Decibles** — from —10 Db to +10/ 36/50/62 based on the Dbm unit: O 1MW in 600 ohms
- **Impedance** — 11 megohms DC, 1 m ohm AC, 10 megohms Lo-Cap
- **Input Capacity** — 130 mmfd. RMS, mmfd. Peak-to-Peak, 25 mmfd. Lo-Ca

Model CT-1 IN-CIRCUIT CONDENSER TESTER

Here is an IN-CIRCUIT CONDENSER that DOES THE WHOLE JOB! The CT-1 actually steps in and takes over where all other in-circuit condensers fail. The ingenious application of a dual bridge principle gives the CT-1 a tremendous range of operation . . . and makes it an absolute 'must' for every serviceman.

in-circuit checks:

- Quality of condensers even with circuit shunt resistance . . . (This includes leakage, shorts, opens, intermittents)
- Value of all condensers from 200 mmfd. to .5 mfd.
- Quality of all electrolytic condensers (the ability to hold a charge)
- Transformer, socket and wiring leakage capacity

out-of-circuit checks:

- Quality of condensers . . . (This includes leakage, shorts, opens and intermittents)
- Value of all condensers from 50 mmfd. to .5 mfd.
- Quality of all electrolytic condensers (the ability to hold a charge)
- High resistance leakage up to 300 megohms
- New or unknown condensers . . . transformer, socket, component and wiring leakage capacity

OUTSTANDING FEATURES

- Ultra-sensitive 2 tube drift-free circuitry
- Multi-color direct scale readings for both quality and value . . . in-circuit or out-of-circuit
- Simultaneous readings of circuit capacity and circuit resistance
- Built-in hi-leakage indicator sensitive to over 300 megohms
- Cannot damage circuit components
- Electronic eye balance indicator for even greater accuracy
- Isolated power line
- Deep brushed long lasting etched aluminum panel
- Housed in sturdy gray hammertone finish steel case . . . comes complete with test leads

Model CT-1 **$34.50 Net**
TERMS: $9.50 within days. Balance $5 mon ly for 5 months.

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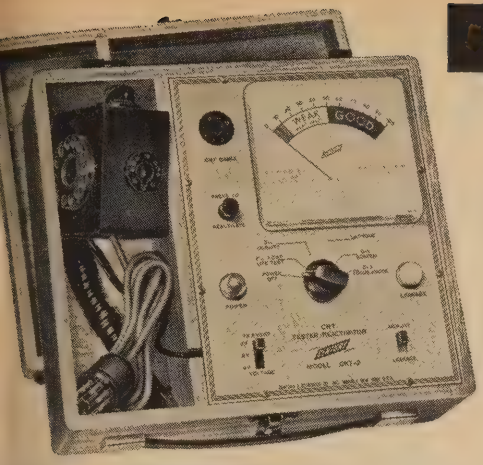
See for yourself at no risk why thousands of servicemen all over the country selected CENTURY test equipment above all others. Send for instruments of your choice without obligation . . . try them for 10 days before you buy . . . only then, if satisfied, pay in easy-to-buy monthly installments — without any financing or carrying charges added.



Housed in hand-rubbed oak carrying case — complete with MULTI-HEAD

Model CRT-2 **$57.50 Net**

TERMS: $13.50 within 10 days. Balance $11 monthly for 4 months.

Model CRT-2 CRT TESTER-REACTIVATOR

TESTS, REPAIRS and REACTIVATES

- ***ALL BLACK AND WHITE PICTURE TUBES*** ***(including 110° tubes)*** . . . from 8" to 30", whether 12 pin base, 8 pin base, 14 pin base . . . and the very latest 7 pin base.
- ***ALL COLOR PICTURE TUBES*** . . . Each of the red, green and blue color guns is handled separately.

CHECK THESE EXCLUSIVE FEATURES

- **THE MULTI-HEAD** (Patent Pending) . . . **A SINGLE PLUG IN CABLE AND UNIQUE TEST HEAD** —A tremendous advance over the maze of cables and adapters generally found with other testers.
- **WATCH IT REACTIVATE THE PICTURE TUBE** — You actually see and control the reactivation directly on the meter as it takes place. This allows you for the first time to properly control the reactivation voltage and eliminates the danger of stripping the cathode of the oxide coating. It also enables you to see whether the build-up is lasting.
- **CONTROLLED "SHOT" WITH HIGHER VOLTAGE FOR BETTER REACTIVATION** — Stronger than any found in other testers — high enough to really do the job — yet controlled to avoid damage to the picture tube.
- **UNIQUE HIGH VOLTAGE PULSE CIRCUIT** — Will burn out inter-element shorts and weld open circuits with complete safety to the picture tube.
- **VISUAL LIFE TEST** — Enables both you and your customer to see the life-expectancy of any picture tube right on the meter . . . helps eliminate resistance to picture tube replacement when necessary.
- **SPECIAL LOW SCREEN VOLTAGE TUBES** — Will handle new type picture tubes with special low voltage of approximately 50 volts.
- **SEPARATE FILAMENT VOLTAGES** — including the very latest 2.35 volt and 8.4 volt types as well as the older 6.3 volt types.
- **NEW 'SF' PICTURE TUBES** — Accommodates the different base pin connections of this new type picture tube.

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TEST
- For quality of every black and white and color picture tube, employing the time proven dynamic cathode emission test principle.
- For inter-element shorts and leakage up to one megohm. Separate short test provided for each element in the picture tube.
- For life expectancy.

REPAIR
- Will clear inter-element shorts and leakage.
- Will weld open elements.

REACTIVATE
- The "SHOT" (high voltage controlled pulse) method of reactivation provided by the CRT-2 will restore picture tube to new life in instances where it was not possible before. The high voltage is applied without danger of stripping the cathode as you always have perfect control of the high voltage pulse.
- The "BOOST" method of reactivation also provided by the CRT-2 is used effectively on tubes with a superficially good picture but with poor emission and short life expectancy. It will also improve definition, contrast and focus greatly and add longer life to the picture tube.

Housed in hand-rubbed oak carrying case complete with CRT ADAPTER

Model FC-2 **$69.50 Net**

TERMS: $14.50 within 10 days. Balance $11 monthly for 5 months.

Model FC-2 FAST-CHECK TUBE TESTER

Simply set two controls . . . insert tube . . . and press quality button to test any of over 900 tube types completely, accurately . . . IN JUST SECONDS!

The FAST-CHECK enables you to cut servicing time way down, eliminate unprofitable call-backs and increase your dollar earnings by selling more tubes with very little effort on your part. You make every call pay extra dividends by merely showing your customer the actual condition and life expectancy of the tube. The extra tubes you will sell each day will pay for the FAST-CHECK in a very short time.

PICTURE TUBE TEST ADAPTER INCLUDED WITH FAST-CHECK
Enables you to check all picture tubes (including the new short-neck 110 degree type) for cathode emission, shorts and life expectancy . . . also to rejuvenate weak picture tubes.

RANGE OF OPERATION

- Checks quality of over 900 tube types, employing the time proven dynamic cathode emission test. This covers more than 99% of all tubes in use today, including the newest series-string TV tubes, auto 12 plate-volt tubes. OZ4s, magic eye tubes, gas regulators, special purpose hi-fi tubes and even foreign tubes.
- Checks for inter-element shorts and leakage.
- Checks for gas content.
- Checks for life-expectancy.

SPECIFICATIONS

● No time consuming multiple switching . . . only two settings are required instead of banks of switches on conventional testers ● No annoying roll chart checking . . . tube chart listing over 900 tube types is located inside cover. New listings are added without costly roll chart replacement ● Checks each section of multi-section tubes and if only one section is defective the tube will read "Bad" on the meter scale ● 41 phosphor bronze beryllium tube sockets never need replacement ● 7-pin and 9-pin straighteners mounted on panel ● Large 4½" D'Arsonval type meter is the most sensitive available, yet rugged — fully protected against accidental burn-out ● Special scale on meter for low current tubes ● Compensation for line voltage variation ● 12 filament positions ● Separate gas and short jewel indicators ● Line isolated — no shock hazards ● Deep brushed long lasting etched aluminum panel.

NOTE: The Fast-Check positively cannot become obsolete . . . circuitry is engineered to accommodate all future tube types as they come out. New tube listings are furnished periodically at no cost.

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- ☐ Model CT-1 In-Circuit Condenser Tester.....$34.50 — $9.50 within 10 days. Balance $5 monthly for 5 months.
- ☐ Model CRT-2 CRT Tester-Reactivator.....$57.50 — $13.50 within 10 days. Balance $11 monthly for 4 months.
- ☐ Model FC-2 Fast-Check Tube Tester.....$69.50 — $14.50 within 10 days. Balance $11 monthly for 5 months.

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Yes, I want to take advantage of your 10 day FREE try-before-you-buy offer. Ship on approval the instruments I have checked. After I have tried the equipment for 10 full days I will either send you the down payment and agree to pay the balance in the monthly payments shown, or I will return the units and owe nothing.

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Please print clearly

Address.....

City.....State.....

(*Continued from page* 101)

3. Cockroaches are an annoying source of trouble. They eat the insulation from wiring, remove the labels from parts and have been known literally to fill if transformer cans where they are electrocuted and can cause intermittent arcing. Since we do not want the things running loose in the shop, the chassis should be placed in a cardboard box and fumigated with a bug bomb. Close up the box for about 30-minutes after a thorough spraying.

Miscellaneous

1. Excessive carbon (soot) in the air from a defective heating plant can cause intermittent arcing in the high-voltage section. The remedy is a thorough cleaning with solvent, and spraying with anticorona dope. Cleansing must be thorough to remove every trace of carbon. Dope must be allowed to dry thoroughly before the set is turned on, otherwise fire may occur. Excessive dust, tobacco smoke, lint or dirt can cause a similar condition.
2. Check for acid fumes in air. A small radio was ruined because it was installed on a shelf over a battery charger and string of storage batteries. An unusual condition of this type should be noted and pointed out to the owner before any work is started. Damage from acids may be impossible to correct, so usually the equipment must be junked. Fortunately, such locations are rare.

Internal troubles

Having eliminated tubes and external causes as trouble sources, we may safely assume the trouble is confined to the chassis. An attempt should be made to classify and isolate the trouble. Intermittents can be classified according to the type of trouble, nature and duration of the cycle (if a definite time cycle is involved) and may be divided into two general groups:

1. The group in which overall operation continues at approximately the normal level, but there is intermittent interference with picture or sound. The interference originates within the chassis and may consist of hash, noisy sound, lines in picture, pulling, distortion of either picture or sound, etc.
2. The group in which operation of some portion of the circuit ceases momentarily and may be restored in any one of several ways. This group may be divided into two general classes:
   a. Those in which overall operation ceases.
   b. Those in which only one section goes dead. This may be: picture dead, sound dead, won't hold, etc.

Regardless of the nature of the intermittent, the routine checking procedure is pretty much the same. Obtain a manual covering the specific chassis involved and a wiring diagram. Checking without the circuit diagram is slower and more difficult.

Chassis check list

Overall mechanical check. Look for:

1. Loose wires, poor insulation, broken wires.
2. Rosin solder joints.
3. Defective tube sockets.
4. Broken or loose controls.
5. Worn-out tuner mechanism.
6. Loose parts.
7. Burned resistors.
8. Overheated transformers or chokes. (Check electrolytics for excessive current drain.)
9. Fluid leakage from capacitors. (Disregard seepage or oil drippings; these are normal.)
10. Signs of overheating, like blistered paint.
11. Bad selenium rectifiers—check by sight and smell, and twist with the fingers to see if plates are loose.

Go over every inch of the chassis, literally, using a pair of long-nose pliers to move wires and parts around as the checking progresses. Many technicians fail on intermittents because they overlook the obvious. The trouble is probably literally staring you in the face—look in the right place and read the signs of burned paint and blackened resistors.

If a thorough mechanical check reveals nothing, proceed with an electrical check.

Overall electrical check

1. Using the variable-voltage isolation transformer, check the lowest voltage at which operation is possible. Gradually raise the voltage, noting any effect on the intermittent condition. Allow the chassis to operate for some time at high line voltage to see if anything breaks down. During this period connect the oscilloscope to the point of greatest suspicion of trouble and look for any changes in waveform as input voltage is varied.
2. If voltage changes seem to have little effect, assemble the hot box and allow the chassis to cook for an hour or so at a high temperature.
3. Check chassis voltages from the data given in the service manual, using the vacuum-tube voltmeter.

Overloading and heat checks have to be made carefully to avoid damaging

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"I once took a JENSEN NEEDLE out of his paw."

good components. Generally speaking, if the chassis is either voltage or temperature sensitive, the effect can be spotted without going to extremes that would damage good parts. This is somewhat like pounding tubes with the screwdriver; they can be broken!

If overloading, high-temperature and voltage checks reveal nothing, other means must be used. If we can by this time pinpoint it to specific circuitry, well and good. Usually, this is difficult, and often impossible if the intermittent condition lasts only a few minutes at a time followed by hours of normal operation.

The really rough ones are often the cases where an oscillator refuses to start without an external shock and where the trouble is due to a case of stable circuitry so balanced that the oscillator does not get the initial "push" to start it off. Any disturbance such as touching the chassis, flipping the power switch rapidly, disconnecting the antenna or even flipping on a room light will start things going. No hard and fast rules can be set for repairing such cases and it may be a matter of trial-and-error substitution. Here is where the potentiometers with test leads attached come in handy. Circuit values can be shifted around until a point of reliable operation is found, and then the values can be measured and replaced with fixed resistors. *Changing circuit values is not for the beginner.* If you find it necessary to alter circuit values, make a little diagram showing what was changed and why the alterations were made. Attach it permanently to the chassis with tape.

Basic causes of intermittents

Tubes We can easily eliminate by substitution all the tubes at once as a source of trouble. There are of course many reasons why tubes cause an intermittent condition—poor welds, loose elements, parts almost touching internally, loose bases, defective heaters, etc. All these are sources of trouble we may not be able to check on a tube tester. *Substitution is the answer.*

Capacitors Capacitors may be either shorted, open or develop internal leakage which will unbalance other circuits. The basic function of a capacitor is to store an electrical charge. If the charge leaks off, the capacitor is like a bucket with a hole in the bottom.

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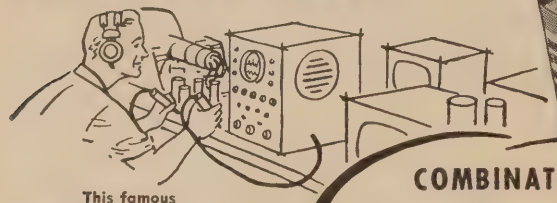

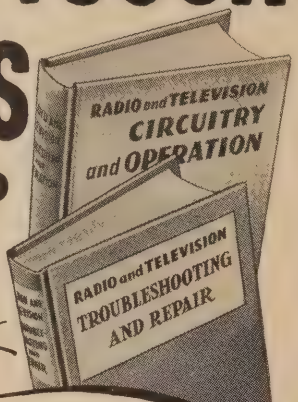

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checking often reveals defects that would otherwise never show up.

Resistors They may be open or they may change in value with age or temperature. They may increase in value rapidly under load. Unless they are temperature-sensitive Globar resistors we want them to remain constant in value. Permanent changes in value can be checked, but the intermittents may check OK cold and open up under load. Some technicians like to check them by temporary overloading. A resistor may be safely overloaded to the point where the paint just starts to blister, but if carried too far such overloading can cause permanent damage. If a resistor is consistently running too warm in a circuit, either it is too small in wattage or some tube or capacitor is passing an excessive amount of current and this is overloading the resistor.

Transformers, chokes, yoke The usual troubles are open or shorted windings. Turns may be intermittently shorted, and this condition is hard to detect. There is an obvious tendency to replace a transformer only as a last resort. Substitution is often the only final answer, but surge checking will frequently show up defects impossible to locate otherwise. To apply a voltage surge, we need only a charged capacitor which is discharged through the transformer winding. Capacitor size and charging voltage depend on the size and type of coil being tested, and the amount of overload that can be safely applied. For small outputs—if, and rf coils—about 2 μf provides a sufficient surge to detect intermittents without danger of damage to the windings. For power transformers, chokes and deflection coils, use a 16-μf capacitor or larger and charge to 300 volts or more. Chokes can be overloaded to the point where the wax starts to melt, provided the overload is removed before the wax actually runs out. Usually an increase of 50% in operating voltage will provide sufficient overload to cause the most obstinate intermittent condition to break down. Additional overloading will only damage good components.

The wise technician will use every method and means at his disposal when tracking down an intermittent. Overloading, heat, pounding, tube substitution, surge checking, careful inspection and a little horsesense are all of value. A final hint for quick and accurate circuit tracing: Using the wiring diagram, take a red or blue pencil and draw a line through each circuit as it is checked or make a check mark at the symbol of each component as it is tested on the chassis. Get a bottle of colored lacquer and a small brush. A nail polish bottle is most convenient. Mark each part as it is tested with a little daub of paint. You can tell when the job is finished, and you will not only save time involved in haphazardly checking some parts two or three times, but will also avoid overlooking the one part that is causing all the trouble. END

How to RETOUCH REPAIR REFINISH CABINETS

Part I—Burns, scratches, gouges and other imperfections in the finish of a cabinet can be removed or hidden. And the work is profitable

By JEFF MARKELL*

PERHAPS you have a good old TV, radio or hi-fi cabinet that you'd like to hang on to. But time has taken its toll and the finish has become rather shabby. Or perhaps you are in the servicing field and get requests from customers to touch up battered cabinets while the insides are in for repair. In either case, you can do a great deal to brighten up a dull, beatup cabinet.

If you are in the servicing business, you doubtless already know what a boon to customer relations even a coat of polish on a cabinet can be. If you haven't tried this simple approach, try it for a while to see if it isn't worth instituting as a standard procedure.

You can give it a fancy name and call it applied psychology if you please, but when a customer gets back a unit that looks better than when she sent it out for repairs, she is likely to think that it plays a great deal better too. And you then have a customer who swears by your work for reasons that have nothing to do with electronics.

If cabinet work goes beyond a routine rubdown and polish, you should charge the customer for it and the matter should be taken up with her before you start. If you see obvious defects or injuries that can be repaired, point them out to the customer when the job first comes in. Suggest that they be attended to while the unit is in for repair. In this way, you can add dollars to your repair billings and build customer satisfaction with the lady of the house at the same time.

If you are tied up with strictly electronic work and can't spare the time for cabinet repairs, make a deal with a local cabinetmaker. In return for the steady volume of business you can provide, he should be willing to give you prices that will let you make a dollar or two on the cabinet work. And you can guarantee professional quality.

Whether you collaborate with a cabinet man or do the work yourself, you still have to know what to look for and what can be done to deal with your customer intelligently. Let's investigate the kinds of defects most often encountered and what can be done about them.

It helps to break down the common types of cabinet defects into two categories. The first consists of various types of injuries resulting from use, wear and tear or transit damage. While such injuries are occasionally serious enough to warrant discarding the entire cabinet, they are usually relatively minor and rather simple to correct. The second category of defects is made up of breakdowns or failures in the cabinet resulting either from old age or construction or finishing methods that were not what they might have been from the start. These will be detailed next month.

Burns are easy

One of the commonest cabinet injuries is burns. About 99% appear on the cabinet tops, and about 98% are cigarette burns. The ones along the edges of the tops are the result of someone's parking a lighted cigarette. The ones in the middle of the top are spots where a lighted cigarette fell off an ashtray.

Burns are easy to detect. They pretty much shout at you. Their size ranges from a very small discolored spot to a large blackened area a couple of inches long and half an inch wide. The size is your tip to how difficult it will be to repair. A large-area burn is generally a deep one. Though it may appear to be superficial, wait until you start scraping away the charred material. You may have to go a lot deeper than you thought to get all the scorched wood out.

There are two ways to treat a burn, but for either one the first step is the same—scraping. All charred material, both finish and wood, must be removed. Do the rough work with a sharp knife—a paring knife with a curved blade, a jack knife or a curved Exacto knife is good.

When you have removed all the burned finish and scraped out all the blackened wood, smooth off the spot

A word of caution to those who have never before attempted to repair or retouch furniture finishes. This type of work is not arduous or heavy labor, but it does require a bit of skill or, if you will, "feel" that can be acquired only with practice. For example, it takes a few tries before you'll get the feel of how much pressure to apply when French polishing, or how long to heat the knife when burning-in. Therefore, before you try your first job for bacon, you ought to practice on an old discarded cabinet or table to get used to the materials and methods. The chances are that your first solder joint wasn't perfect either.

*Markell Associates, Cabinet Design and Construction.

with very fine sandpaper, 2/0 to 4/0, and stain it to match the surrounding area.

French polishing

Now you have to decide which way to retouch, the decision depends on how deep a hole you have in the surface after scraping. If the depth of the scraped-out spot is ⅛ inch or less, use a method known as French polishing. Make a small pad of cheesecloth or gauze about 1½ inches square and about 20 layers thick. Wet the pad with white shellac and squeeze out the excess so the pad is soggy but not dripping. Then pull up the four corners in your fingers to make a round ended pad, and apply 3 or 4 drops of linseed oil to the rounded portion. With a brisk motion, rub the shellac into the affected area. At first, apply very little pressure. After a few seconds, the shellac will start to harden and you can apply more pressure—about what you would use to polish hard wax. Keep repeating this process, working shellac into the burned area and around the edges until you have built it up level with the rest of the top. When you are finished, the spot you have been doctoring will be glossy. If the rest of the piece is satin finished, dull the repaired spot down with extremely fine steel wool, 4/0 sandpaper or pumice.

Burning in

French polishing is fine for a shallow burn, but what do you do if you have a deep one? More than ⅛ inch. Again it's easy. After the burned area has been scraped out, sanded and stained to match the surrounding color, you use a technique called burning in. For this you need an alcohol lamp, a small flexible spatula (a light, springy artist's palette knife is excellent) and a shellac stick either transparent or a color that matches the piece being repaired.

Heat the palette knife over the alcohol lamp. Touch the heated knife to the shellac stick and melt a small amount of material from it. Place it in the hole to be filled. Repeat the process, filling the hole a little at a time until it is level with the surrounding area. Do not overheat the knife or the shellac will burn, creating carbon that will smudge the repair. You need only enough heat to melt a little of the shellac stick at a time. When the hole is filled, use the heated knife to smooth the surface around the edges. Again be careful not to overheat the knife or it will blister the surrounding finish. Complete your smoothing operation by sanding lightly with the finest possible paper, about 4/0, and top off with French polish or rub with steel wool or pumice, to make the repair conform with the surrounding texture.

Water and beverage stains

Opaque or semi-opaque milky areas on cabinet tops are usually water or beverage stains. They may be in the form of rings left by the bottoms of wet glasses, or irregularly shaped areas caused by spilled beverages that were allowed to stand.

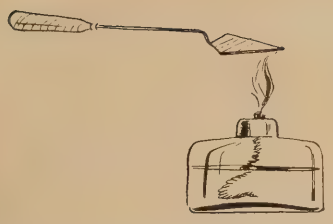
There are two ways to remove these annoying white spots. One is by rubbing them out, and the other is by chemical action. Since such spots do not generally penetrate clear through the finish, try rubbing them out first.

On a dull finish, use very fine steel wool and oil. On a semi-gloss finish, use pumice; on a high-gloss finish, rottenstone. Merely rub the spot with the

Cigarette burns are the most common type of cabinet damage.

Illustrations Gernsback Library

The ring left by glass standing on the top of a cabinet is easy to remove—if you know how.



For burning-in, you will need an alcohol lamp and a spatula as well as some shellac sticks.

appropriate abrasive until it disappears.

If rubbing doesn't seem to affect the spot much, switch to a chemical treatment, since you've apparently got a spot that goes fairly deep. The trouble with chemical methods is that if the chemicals are too strong or are left on too long they'll take the finish off the area entirely, so you have to be very careful.

One method is to use ammonia. Dampen a soft rag or cheesecloth with ammonia, then wring the pad out as hard as you can. Now, **very gently, quickly and lightly,** brush the ammonia across the white spot. For bad white spots on lacquer finishes, do the same thing with lacquer thinner. **I cannot caution you too strongly to work quickly and lightly, lest you take all the finish off along with the spot.** If this happens, you've a job of French polishing on your hands.

Scratches

Little ones, big ones or both, you will find scratches on every used piece of furniture. The primary trouble with the appearance of an old cabinet is often a myraid of little scratches whch give it a terribly dull, defeated-looking appearance. Most of them can be compounded out both easily and rapidly. This is where you might get a life-long customer by expending just a little effort.

Most scratches can be removed by rubbing with 4/0 steel wool, pumice, rottenstone and oil, furniture rubbing compound, or even automobile rubbing compound, depending on the amount of gloss desired in the final result.

When you do a routine good-will type of polishing job, don't try to get all the scratches out. You'll get most of them out with a brief rubdown with the proper abrasive, and this way you get the effect you want — appreciably brightening the appearance of the cabinet without going to a lot of work and expense.

For a dull satin finish, use the steel wool. On a semi-gloss, use pumice and oil or pumice and water. For a high gloss finish, use furniture rubbing compound. If you can't find any, use automobile rubbing compound. It's just about the same. In the unlikely event that you cannot find either one locally, use rottenstone and oil. The high gloss is, of course, the most exacting finish to clean up because it shows finer scratches than either of the others. When you are through rubbing out the scratches, go over the whole piece with a good furniture polish to complete the job properly.

You'll often find that by rubbing only the top and applying furniture polish to the entire cabinet you will get the desired effect, since the largest proportion of scratches will be on the top.

Where you really want to get out all the scratches, and there are some deep or stubborn ones that do not respond to rubbing alone, try French polish and then rub out.

Nicks and gouges

There are dozens of ways in which a cabinet can be hit or scraped, nicked or gouged, either in transit or around the house. The simplest nicks require more labor to repair than scratches, and they can be big and deep enough to be impossible to repair completely. If they are really big, you can reduce the unsightliness considerably, but don't give anyone the idea that you are going to make them disappear entirely.

All deep depressions require the same treatment. The first step is to clear away all loose splinters and chipped finish in and around the area. Stain where restoration of color is required, and burn in with alcohol lamp, spatula and shellac stick as described previous-

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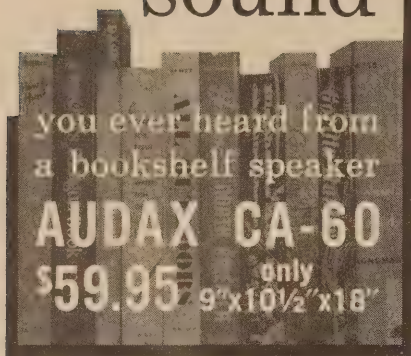

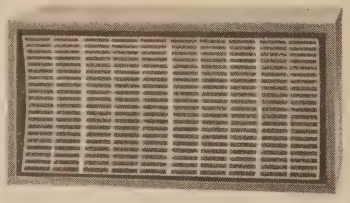

Among many individuals, there is a need to minimize on the space to be devoted to a component stereo system. A rash of "bookshelf" types have appeared in an attempt to meet this need. In practice, however, they seem neither fish nor fowl,...either too large for compactly spaced bookshelves or too small for use as free-standing units.

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Burn holes can be filled with shellac.

ly. I prefer using transparent shellac sticks for burning in since the transparent type allows grain and color to show through, making a better match with the surrounding area than is usually possible with opaque, colored shellac sticks. After burning in, finish off by smoothing out and polishing as with with other types of injuries.

Crushed edges and corners

When a cabinet is dropped during transit, the usual result is a crushed corner or edge. Like deep nicks and gouges, this type of damage can be vastly improved, but cannot always be repaired 100%. One word of caution: before you even think of doing anything about a crushed corner, examine the joint alongside it and all other joints, particularly the one diagonally across from the damaged one. Check for joints that are sprung and have started to split open. If the joints have started to go, the structural integrity of the entire cabinet is in serious trouble. In severe cases, the cabinet may have to be discarded.

Crushed corners or edges are another form of damage you would treat with a shellac stick and burn-in. When repairing a crushed corner, use your judgment as to how far to try to rebuild it. It is usually inadvisable to try to build up a badly crushed corner to its full original shape. The new corner would be very fragile — it is made only of shellac. Build up bad crushes say ¼ inch or a bit more and stop. The damage won't be completely hidden, but it will be a great deal less obvious, and the repair will be more likely to stay in place.

Loose or broken hardware

Hinges that are wobbly because of loose screws, hinges bent out of shape, bent lid supports that won't open or won't support, door catches that won't catch, drawer slides that won't slide, all fall under the head of loose or broken hardware. A lot of the trouble caused by such problems is secondary — scratching and scarring caused by continued use of the cabinet after the hardware has gone west.

As a general rule, the best thing to do with bent or broken hardware is to take it off and replace it. A bent or broken hinge, catch or lid support will never be quite right if you try to fix it. On an antique piece with antique hardware that cannot be replaced, you have no choice but to try and repair it. Otherwise, don't waste your time.

One of the most common troubles with hardware is not that the hardware itself is damaged, but merely that the screws holding it in position have stripped their threads in the wood and

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loosened. Rather than replace them with larger screws that may not fit the hardware, remove the screws, fill the holes with plastic wood and while the plastic wood is still soft, redrive the screws. Caution! Drive only until the screw heads are flush—any more and you'll pull the plastic wood right back out. Give the plastic wood time to set, and you'll find the hardware is tight again.

This completes our discussion of the more common cabinet injuries. Deterioration due to age or construction failures in a cabinet result in other symptoms and treatments. Next month we treat some of the harder-to-handle troubles. We start off with cracked, glazed or alligatored finishes, continue on to open joints, work over some loose legs and molding and finish up with refinishing. TO BE CONTINUED

CURE DISCOVERED FOR TV TUBES!

A Texas scientist, noted for his extensive research in the field of aniline dyes and the pre-natal dying of wool, which has gained him world-wide recognition as the world's foremost lamb dyer, has at long last isolated a heretofore unsuspected valve in receiving tubes which seriously limits the tube's capability and useful life. It has long been felt in engineering circles that tubes would pass both mc's and kc's. It has now been shown that acidic atmospheres in vacuum tubes cause a little door to close over the valve and prevent the free passage of mc's, which all will recognize as fatal.

Five New York doctors verified these findings and report that their sets work better when the tubes are treated with XL-9, a secret formula prepared by the Texas Institute.

XL-9, containing a slight trace of lanolin extracted from pre-natal lamb's wool together with three other as yet unspecified ingredients, when applied to the outside of receiving tubes has the property of easing internal stresses and allows the free passage of mc's and kc's.

Leading tube engineers say that the discovery of the hidden valve is a complete surprise to them and that their quality-control sections have never listed this on their reports. Both CGS and Rayvania have ordered large shipments of new formula XL-9, which they promise will coat each tube leaving their plants in the future.

Service technicians all over the country hail this discovery as the greatest boon to set owners of all time, and are making plans to award a plaque to the Texas Institute in recognition of its great contribution to mankind.—*Reprinted from TESA (of Seattle) News.*

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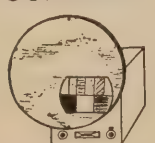

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TV Service CLINIC

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WE'VE had a lot of inquiries lately about yokes—testing, substituting and so on. Several readers have asked for a brief discussion of this, so here goes.

Beside the standard symptom of yoke trouble, which is a trapezoidal raster, there are several other reliable indications. The best of these is the absence of boost voltage—your damper tube will have only B-plus on both cathode and plate. A good rule for boost-voltage value is that it should be at least 100 volts above the B-plus. So if the raster is dim or nonexistent and the boost is gone, look for trouble in or around the yoke.

There are several ways. The quickest is a regular flyback-yoke tester. The suspected component is connected across this. If it has any shorted turns or other defects, they will show up on the meter reading. Actually, this tunes the yoke or flyback to resonance and reads the output. A short will lower the winding's Q so far that the meter reading will be much lower.

A good home-made test is the substitution of a yoke with duplicate characteristics. Note that in this test we're not interested in getting a complete yoke with the exact characteristics needed. All we need is a yoke that is within about 20% of the inductance value of the original, so that we can be certain that the original is defective.

Most of us have at least two or three new yokes in stock. One of them should come close enough for test purposes. If not, a yoke from another TV set may be used. Disconnect the horizontal windings of the original and connect the test yoke. Now, measure high voltage, boost, etc., to see if it comes back to normal. If so, the original yoke is defective. Before discarding it though, take a good look at wiring, the balancing network and the connecting leads. Many yoke troubles come from minor wiring shorts or loose connections.

There is a certain amount of tolerance in yoke inductance, but not too much—15% to 20% according to various authorities. Fortunately, there are only about 10 inductance values in common use in horizontal yokes, and 5 in the vertical sections. There are a large number of combinations of these values, of course. Table I shows the range of inductance to be expected in each section.

TABLE I
Inductances of Deflection Yokes

Horizontal (*mh*)	Vertical (*mh*)
8.3	3.5
10.3	11.5
12.5	12.3
13.5	40.0
18.5	42.0
19.0	48.0
25.0	50.0
30.0	

Some typical symptoms of yoke trouble are trapezoidal pictures, ringing in the raster causing wrinkles and bright lines at the left side (look for the telltale bending of the scanning lines that denote raster instead of video troubles), insufficient height or width. Either of the last two may be found with or without the trapezoidal shape. A very good indication is a loss or lowering of boost voltage. Watch out for troubles which seem to be in the yoke but aren't. Typical of these are open boost filter capacitors which can cause a wrinkled and slightly trapezoidal raster. This usually happens in sets which draw vertical output current from the boost. A tipoff to this is found in the vertical linearity control which will act as a brightness, width and high-voltage control all in one! The brightness control will also change the shape of the raster.

If you lack information about the yoke, a rough guess can be made from the dc resistance. Table II gives the approximate resistance values for the

TABLE II
Inductance vs Resistance of Deflection Yokes

Inductance (mh)	*Resistance (ohms)*
Horizontal	
8–10	13–15
12–14	18–20
18–21	30
24–25	38–40
30	50
Vertical	
3.3	3.6
40	40–45
45	50–55
48	55–65

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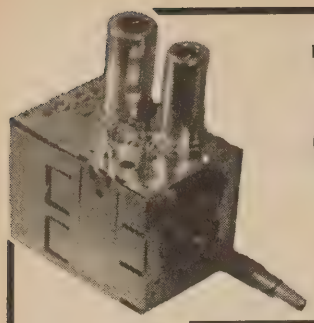

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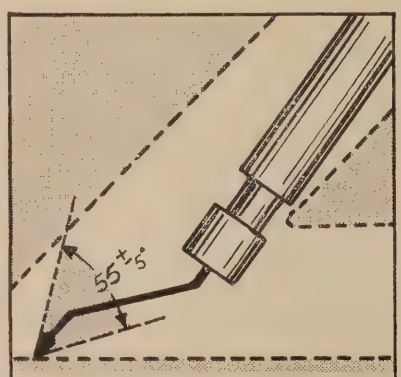

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various yoke windings. This should be used for substitution tests only, unless no service information at all is available, a situation seldom found today. Service literature from manufacturers, service-data publications and yoke manufacturer's catalogues, all have very comprehensive lists of almost all sets made within the last several years. If half of a yoke winding is burned up, resistance measurements can be made by reading the undamaged half, then doubling the reading. When replacing the yoke, be sure to duplicate the R-C network originally used, for the best matching and elimination of ringing in the raster.

Picture smear

How can picture smear in an Admiral 14YP3 be prevented when the picture-tube leads are extended approximately 2½ feet?—D. M. K., Davenport, Wash.

The picture smear is caused by excessive shunt capacitance at the video amplifier output, caused by the extended leads to the picture tube. You won't have to use a cathode follower if the stray capacitance of the video signal lead is held to a low value. The lead should be suspended in free space and not run close to metal surfaces.

Zero reference levels

What is the meaning of ac and dc zero-reference levels on scope screens, for which I cannot find answers in any text?—O. T., Los Angeles, Calif.

The ac and dc zero-reference levels are given by the beam resting position on the scope screen, with no input signal. A dc scope provides a dc zero-reference level. An ac scope provides an ac zero-reference level. Consider a power supply having a ripple voltage.

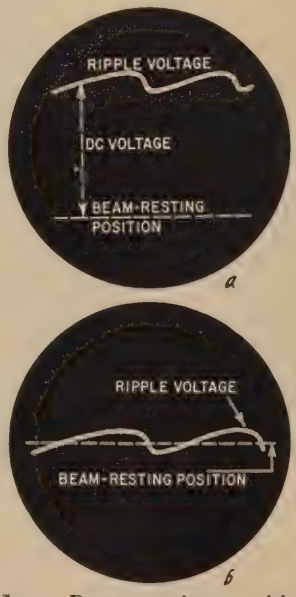

Fig. 1-a — Beam resting position of trace in a dc scope is the dc zero-reference level: b—beam resting position of trace in an ac scope is the ac zero-reference level.

Both ac and dc output are present. We sometimes call the output a pulsating dc voltage. As shown in Fig. 1-a, a dc scope displays both the ac and dc voltage components with respect to the beam resting position. The ripple pattern rises above the dc zero level by a distance proportional to the dc component. The percentage of ripple (ac) is given by its peak-to-peak voltage with respect to the dc voltage deflection. On the other hand, an ac scope shows only the ac component, as indicated in Fig. 1-b. The ripple waveform is centered on the beam resting (zero ac) level.

Hole in the raster

A Crosley G21TOWH chassis has developed what we call "hole-in-the-raster" trouble! From 30 minutes to 3 hours after it is turned on, a small notch in the upper right-hand corner of the screen blacks out. It grows until it has blacked out about 6 square inches of the picture. There is very little or no foldover around the edges. The hole moves with the raster or picture when the vertical hold is moved, its position staying fixed relative to the raster. We have substituted several parts, including the yoke, flyback, picture tube and a complete low-voltage power supply with filters. An external horizontal drive has been used for the output.—J. M., Tupelo, Miss.

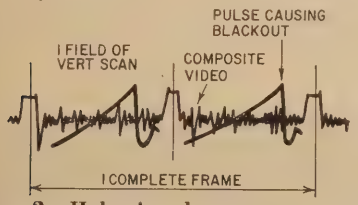

Fig. 2—Hole in the raster can be caused by a spurious pulse in the field scan.

This is indeed an unusual trouble! The fact that the hole moves with the raster when the vertical hold control is moved rules out my first thought—stray magnetic fields developing within the cabinet or yoke, etc. or a defective dag coating on the picture tube (causing a negative electrostatic field to develop inside the bulb). The clue here is that the hole rolls with the vertical scan. Its origin must then be in the vertical output stage since it is synchonized with its output. To black out the tube in any place, the CRT must receive a pulse of voltage of the proper polarity on its grid or cathode. Therefore, we now have two facts—a pulse of voltage is getting into the video channel (either into the video amplifier or CRT circuits themselves) and this pulse is originating in the vertical output circuit (the most likely, since the highest pulse voltages are present there).

Take careful measurements with a scope on the video input to the picture tube, also in the video amplifier stage. Pull the video amplifier tube or disable it to see whether the trouble is originating before or after the video amplifier grid. You'll probably find a pulse volt-

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age in the field scan. It would have to be shaped roughly like the one shown in Fig. 2 to cause the effect noted.

Check or replace the 5-μf capacitor between the brightness control and the 260-volt line, and the 20-μf unit between the vertical linearity control and B-minus. They have been known to cause some very unusual symptoms in this chassis. There is also the possibility of interelement leakage in the multiple electrolytics.

Alignment problem

I am working on a Mattison 630 and am having difficulty with alignment. On an if sweep check, the 27.75-mc trap after-response shows up normally. But when sweeping at rf through the antenna input terminals, the response slopes off and the after-response disappears. I do not get clear image outlines on channel 2. Edges show grain or waving lines. Is this caused by a picture carrier too low on the curve, or by regeneration?—G. L. S., Mercer, Pa.

The after-response may not show up on an overall sweep check for two reasons: First, the rf response may be attenuated in this region. A separate rf tuner alignment check should be made. Second, you may have limited rf sweep output from your generator, so insufficient signal is applied at rf to provide a true comparison with the if sweep response. There is also the possibility of mixer regeneration. This can be checked by turning the channel-selector switch while sweeping the if amplifier—use a floating tube shield over the mixer tube. If the if curve changes substantially in this test, the tuner needs attention or replacement. The grain is caused by inadequate rejection of the sound carrier. Check settings of the sound traps with an accurate marker generator. Waving lines at the edges of objects can be attributed to several causes in a weak-signal area. Without a more definite and detailed description, it would be difficult to tie this down.

Sync buzz

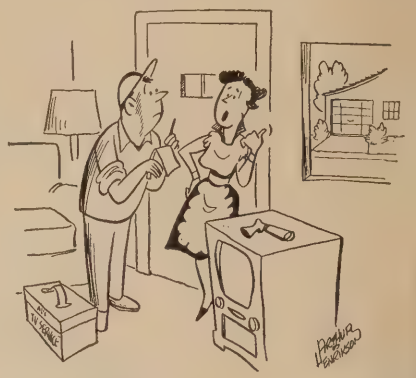
Can you recommend an FM detector and driver circuit to replace a slope discriminator in a Hyde Park 172? I am interested in minimizing sync buzz. —J. B. E., Jr., So. Plainfield, N. J.

A limiter ahead of the FM detector is most effective in eliminating sync buzz. In view of the circuit now in use, I would suggest elaborating along the lines of the Tele-Tone TV-316. The present 25L6 can be used.

Critical horizontal oscillator

I have been having difficulty with the horizontal oscillator circuits in CBS 1621 chassis, which are made in Canada. The last one required critical selection of 6SN7 and 6DQ6 tubes. A 6CU6 taken from another set because of pie-crust operates satisfactorily in place of the specified 6DQ6-A. Can you suggest the cause of the trouble?—R. A. W., Port Severn, Ont.

The need for selecting 6SN7's can be correlated with their cutoff characteristics. Various tube manufacturers have quality-control procedures to weed out 6SN7's with remote cutoff. A few tube testers will check cutoff. The difficulty with the 6DQ6's has a familiar ring. It is very likely that the tubes that give unsatisfactory oscillation are being "bugged" by parasitic oscillation. Try inserting 47-ohm resistors in series with the grid, plate and screen-grid leads, at the socket terminals. Standard heater chokes in series with the heater leads may also help. END



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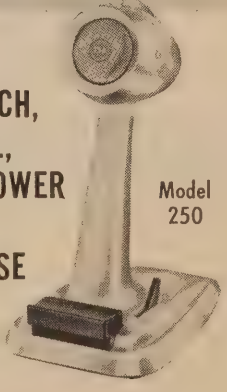
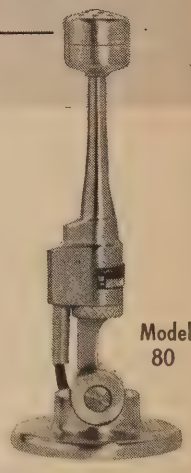


Model 250

The Turner "Lift - Switch" Model 250 dynamic offers you more versatility, convenience and ease of operation than any other microphone. Wired to operate both relay and mike circuits at a touch. Has Turner's exclusive 3-way switching. 1) Lift the mike, it's live; 2) depress the front bar for push-to-talk; 3) move the lever-lock forward. The mike is live and stays live. The model 250 is a high impedance microphone. Response; 60 - 10,000 c.p.s. Level; -52 db. Complete with single unit die-cast case and 20 ft., three conductor (one shielded) cable. Furnished in satin chrome. List $49.50.

GENERAL PURPOSE



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CITIZENS' BAND transceiver *model BS-27* includes tunable superregenerative receiver, also covers amateur 10-meter band. Receiver sensitivity 1 mv or better. Transmitter input to final rf amplifier 5 watts. Includes under-dash mounting bracket.—**Kay-Townes Antenna Co.,** Box 593, Rome, Ga.

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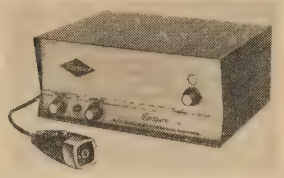

SSB COMMUNICATIONS RECEIVER *model HQ-180* 550 kc to 30 mc in 6 ranges. 18-tube superhet, noise limiter, adjustable crystal filter, adjustable sidebands, 7-position if selectivity, 4-position avc switch, built-in crystal calibrator. Signal-to-noise ratio 20 db with 0.5-μv CW input. Rack-mounting or in cabinet.—**Hammarlund Mfg. Co., Inc.** 460 W. 34 St., N. Y. 1, N. Y.

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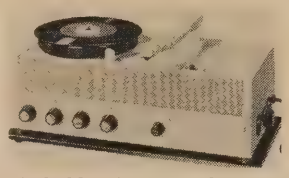

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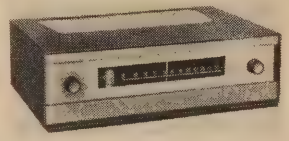
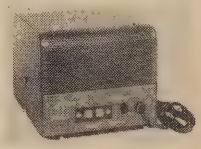
TUNER AND AMPLIFIER KITS *models 20LJK* and *101-GTK* (tuner shown). *20-LJK* stereo amplifier, two 10-watt power amplifiers, response ±0.5



db 20–20,000 cycles, hum and noise 80 db down. Function, balance, loudness, bass, treble controls. Tuner has tuning eye, afc, two limiters. Both also available wired.—**Grommes Div., Precision Electronics, Inc.,** 9101 King St., Franklin Park, Ill.

TV-FM AMPLIFIER for distribution systems. Wide-band unit delivers 22-db gain on FM and low TV channels, 24-db gain on high channels. Output



0.7 volt at 75 ohms, 1.4 volts at 300 ohms. "No-strip" screw terminals, 75-ohm coaxial fittings provided. Power supply 117 volts ac.—**Blonder-Tongue Laboratories, Inc.,** 9 Alling St., Newark 2, N.J.

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drives monitoring headphone or external accessory amplifier. 8½ x 1⅞ x 3⅞ in. Weighs under 3 lbs.—**Mohawk Business Machines Corp.,** 944 Halsey St., Brooklyn 33, N.Y.

AUDIO MIXER *No. 313* for tape recorders, especially Revere and Wollensak models, using shorter than standard

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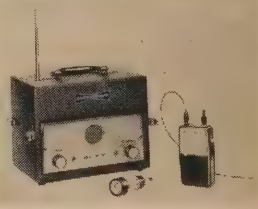
WIRELESS MICROPHONE *model CR-4,* FM transmitter and receiver for wireless communications systems, nightclub



work, auditoriums, warehouses, hospitals, etc. Miniature FM transistor transmitter, 8-tube FM receiver with wide-band afc. 27.12 mc, no license required.—**Superscope, Inc.,** 8520 Tujunga Ave., Sun Valley, Calif.

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SPEAKER CROSSOVER network is variable high-pass fil-

ter. Control adjusts crossover and signal level. For use with 4- to 16-ohm woofers and amplifier outputs. All connections made with screw terminals.—**Olson Radio Corp.,** 260 S. Forge St., Akron, Ohio.

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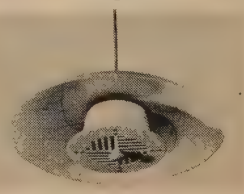

sound downward from 14-, 18- or 24-inch (shown) glass fiber reflector. Hung by chain, or rigidly attached to ceiling by rod, or sunk into ceiling.—**Fourjay Industries,** 2360 W. Dorothy Lane, Dayton 39, Ohio.

BOOKSHELF SPEAKER system *model Polaris.* Tweeter uses reflector to provide wide-angle

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	1AX2	.62		4BZ7	.96		6BC7	.94		6K6	.58		12AZ7	.86		12U7	.62
	1B3GT	.79		4CB6	.59		6BC8	.97		6S4	.48		12B4	.63		12V6GT	.53
	1DN5	.55		4CS6	.61		6BD6	.51		6SA7GT	.76		12BA6	.50		12W6	.69
	1G3	.73		4DE6	.62		6BE6	.55		6SK7GT	.74		12BD6	.50		12X4	.38
	1J3	.73		4DK6	.60		6BF6	.44		6SL7	.80		12BE6	.53		17AX4	.67
	1K3	.73		4DT6	.55		6BG6	1.66		6SN7	.65		12BF6	.44		17BQ6	1.09
	1L6	1.05		5AM8	.79		6BH6	.65		6SQ7	.73		12BH7	.73		17C5	.58
	1LA6	.69		5AN8	.86		6BH8	.87		6T4	.99		12BK5	.70		17CA5	.62
	1LC6	.79		5AQ5	.52		6BJ6	.62		6T8	.80		12BL6	.56		17D4	.69
	1LN5	.59		5AT8	.80		6BK5	.80		6U8	.78		12BQ6	1.06		17DQ6	1.06
	1R5	.62		5BK7A	.82		6BK7	.85		6V6GT	.54		12BY7	.74		17L6	.58
	1S5	.51		5BQ7	.97		6BL7	1.00		6W4	.57		12BZ7	.75		17W6	.70
	1T4	.58		5BR8	.79		6BN4	.57		6W6	.69		12C5	.56		19AU4	.83
	1U4	.57		5CG8	.76		6BN6	.74		6X4	.39		12CA5	.59		19BG6	1.39
	1U5	.50		5CL8	.76		6BQ5	.65		6X5GT	.53		12CN5	.56		19T8	.80
	1X2B	.82		5EA8	.80		6BQ6GT	1.05		6X8	.77		12CR6	.54		21EX6	1.49
	2AF4	.96		5EU8	.80		6BQ7	.95		7AU7	.61		12CU5	.58		25AU4	.87
	2BN4	.60		5J6	.68		6BR8	.78		7A8	.68		12CU6	1.06		25BQ6	1.11
	2CY5	.71		5T8	.81		6BS8	.90		7B6	.69		12CX6	.54		25C5	.53
	3AL5	.42		5U4	.60		6BU8	.70		7Y4	.69		12DB5	.69		25CA5	.59
	3AU6	.51		5U8	.81		6BY6	.54		8AU8	.83		12DE8	.75		25CD6	1.44
	3AV6	.41		5V6	.56		6BZ6	.54		8AW8	.93		12DL8	.85		25CU6	1.11
	3BA6	.51		5X8	.78		6BZ7	.97		8BQ5	.60		12DM7	.67		25DN6	1.42
	3BC5	.54		5Y3	.46		6C4	.43		8CG7	.62		12DQ6	1.04		25EH5	.55
	3BE6	.52		6AB4	.46		6CB6	.54		8CM7	.68		12DS7	.79		25L6	.57
	3BN4	.63		6AC7	.96		6CD6	1.42		8CN7	.97		12DZ6	.56		25W4	.68
	3BN6	.76		6AF3	.73		6CF6	.64		8CX8	.93		12EL6	.50		25Z6	.66
	3BU8	.78		6AF4	.97		6CG7	.60		8EB8	.94		12EG6	.54		35C5	.51
	3BY6	.55		6AG5	.65		6CG8	.77		10DA7	.71		12EK6	.56		35L6	.57
	3BZ6	.55		6AH6	.99		6CM7	.66		11CY7	.75		12EZ6	.53		35W4	.52
	3CB6	.54		6AK5	.95		6CN7	.65		12A4	.60		12F5	.66		35Z5GT	.60
	3CF6	.60		6AL5	.47		6CR6	.51		12AB5	.55		12F8	.66		50B5	.60
	3CS6	.52		6AM8	.78		6CS6	.57		12AC6	.49		12FM6	.45		50C5	.53
	3CY5	.71		6AN4	.95		6CU5	.58		12AD6	.57		12K5	.65		50DC4	.37
	3DE6	.62		6AN8	.85		6CU6	1.08		12AE6	.43		12SA7M	.86		50EH5	.55
	3DK6	.60		6AQ5	.50		6CY5	.70		12AF3	.73		12SK7GT	.74		50L6	.61
	3DT6	.50		6AR5	.55		6CY7	.71		12AF6	.49		12SN7	.67		117Z3	.61
	3Q5	.80		6AS5	.60		6DA4	.68		12AJ6	.46						
	3S4	.61		6AT6	.43		6DB5	.69		12AL5	.45						
	3V4	.58		6AT8	.79		6DE6	.58		12AL8	.95						
	4AU6	.54		6AU4	.82		6DG6	.59		12AQ5	.52						
	4BA6	.51		6AU6	.50		6DQ6	1.10		12AT6	.43						
	4BC5	.56		6AU7	.61		6DT5	.76		12AT7	.76						
	4BC8	.96		6AU8	.87		6DT6	.53		12AU6	.50						
	4BE6	.54		6AV6	.40		6EU8	.79		12AU7	.60						
	4BN6	.75		6AW8	.89		6EA8	.79		12AV5	.97						
	4BQ7	.96		6AX4	.65		6EB8	.94		12AV6	.41						
	4BS8	.98		6AX7	.64		6H6GT	.58		12AV7	.75						
	4BU8	.71		6BA6	.49		6J5GT	.51		12AX4	.67						

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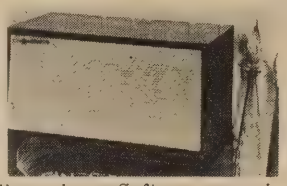


dispersion. Soft - suspension woofer. L-C crossover network. High efficiency, fully driven by amplifiers from 10 watts up. Response 35–17,500 cycles. Fits any 12-inch bookshelf.—**Alcor, Inc.,** Green & Tioga Sts., Ithaca, N. Y.

STEREO RECEIVER *model 399* combines 2 power amplifiers 2 preamps, FM and AM tuners, and complete stereo controls on one chassis. Output 20 watts

per channel, connections provided for third channel output to drive mid-channel speaker. Includes all features of Scott 299 stereo amplifier and 330D AM–FM stereo tuner. Highly flexible controls include phase reverse.—**H. H. Scott, Inc.,** 111 Powdermill Road, Maynard, Mass.

TRANSISTOR STEREO AMPLIFIER *model S-25.* Integrated stereo amplifier, preamp–control unit. 25 watts per channel, response ±1 db 20–20,000 cycles

at full output. Distortion under 0.8%. Hum 100 db down. Tape head, low-level microphone inputs. Flexible controls provide all stereo switching functions. Powered by 117 volts ac or 12 volts dc.—**Transis-Tronics, Inc.,** 1650 21 St., Santa Monica, Calif.

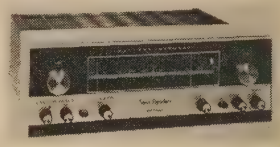
STEREO AMPLIFIER *model X-202* complete control center, dual 25 - watt (music - power rating) power amplifiers on one chassis. Distortion 0.8% at 25 watts. Controls include output

to drive center-channel power amplifier, blend and balance, scratch and rumble filters. Accepts company's remote-control accessory. Indicator lights show operating mode.—**Fisher Radio Corp.,** 21-21 44th Drive, Long Island City 1, N. Y.

STEREO TUNER *Knight KN-125,* 2 complete tuners on a chassis. FM sensitivity 1.2 μv, 20-db quieting, includes afc and

adjustable dynamic sideband regulation and 50-ohm shielded antenna input. AM tuned rf stage, 3-position bandwidth switch, 10-kc whistle filter, sensitivity 4 μv for 20-db signal - to - noise ratio. — **Allied Radio Corp.,** 100 N. Western Ave., Chicago 80, Ill.

STEREO TUNER–PREAMPS *models SR-7000* (shown) and *SR-8000* combine FM, AM tun-

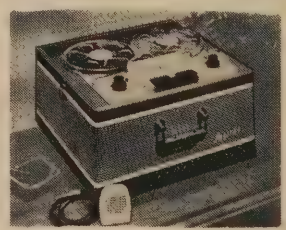


ers, preamp and control units on one chassis. Separate tuning indicators for FM and AM, switches control FM afc, AM bandwidth, loudness – volume control, output phase. Other conventional controls included. —**Sargent-Rayment Co.,** 4926 E. 12 St., Oakland, Calif.

STEREO RECORDER *model 970* similar to *model 960* with addition of two 5-watt monitoring amplifiers, two 7-inch

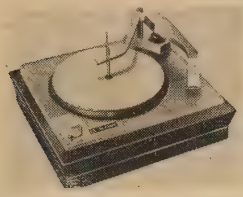
oval speakers. Sound from speakers beamed by adjustable sound-directing panels at each end of long portable case. Monitoring off tape during recording available through totally separate record and playback amplifiers and heads. Plays back mono, 2- or 4-track stereo, records mono or 2-track stereo. Jacks for headphones or external speakers disable internal speakers. 2 high-impedance line inputs, 2 high-impedance microphone inputs separate level controls for each. Dynamic range 55 db at 7½ ips. Head gap 90 millionths inch.—**Ampex Audio, Inc.,** 1020 Kifer Road, Sunnyvale, Calif.

STEREO PLAYBACK TAPE machine *model 692* records mono, plays back 2-track, 4-track



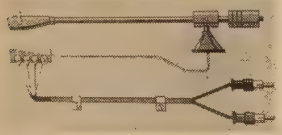
tapes without head adjustment or switching. 2-speed unit has pushbuttons, two power amplifiers, two 5 x 7-in speakers. Response 70 to 12,000 cycles. Compartment in case accommodates optional radio tuner. —**Recordio Corp.,** Charlotte, Mich.

STEREO DISC CHANGER *model GS-400.* Low-priced phonograph player handles all sizes discs mixed in any sequence. Plays manually or automatically. Arm may be held during



change cycles without damage. Muting switch during cycle. Quick-change cartridge holder. 2 separate shielded 2-conductor cables from cartridge minimize hum loops. Vernier stylus pressure adjustment. Precut bases available.—**Glaser-Steers Corp.,** 155 Oraton St., Newark 4, N. J.

STEREO CONNECTING CABLE *model KK-1,* with spade terminals at one end connecting screw terminal strip from

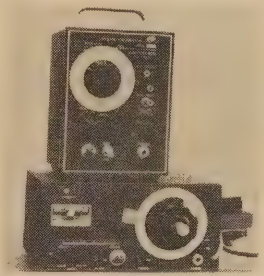


stereo tone arm to phono inputs of amplifier. Designed for company's tone arms, works with other arms as well.—**Rek-O-Kut Co., Inc.,** 38-19 108 St., Corona 68, N. Y.

MINIATURE CAPACITORS *type MTWK.* Metalized paper–plastic film units for industrial, military and similar equipment. Temperature range −55° to +125°C. without voltage derating. Hermetically sealed tubular metal cases with glass-to-metal end seals in various

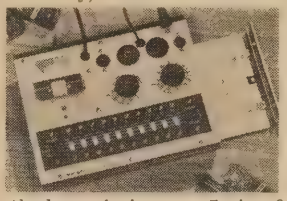
mounting styles (photo). Full range of capacitances in 200-, 400-, 600-volt sizes.—**Cornell-Dubilier Electric Corp.,** South Plainfield, N. J.

MICROMETER FREQUENCY METER *model 105-B* used with any station WWV receiver and



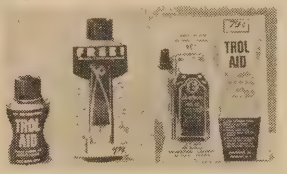
modified *model 111* Measurements Corp. crystal calibrator measures transmitter frequency from 50 to 500 mc with accuracy better than one part per million (.0001%). *PPM* package includes modified crystal calibrator.—**Lampkin Laboratories, Inc.,** Bradenton, Fla.

TUBE-CHECKER KIT *model 400.* Compact unit checks 400 types of tubes. Shows filament continuity, shorted elements,



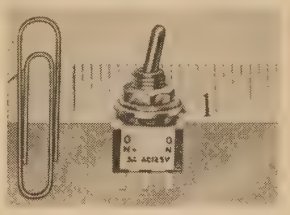
cathode emission on 7-pin, 9-pin, octal and loctal tubes. Scales marked in red and green bands "Replace–Good." Special diode-checking scale.— **Allied Radio Corp.,** 100 N. Western Ave., Chicago 80, Ill.

CONTACT-CONTROL CLEANER "*Trol-Aid*" non-toxic volume control and contact lubricant–cleaner contains no carbon tetrachloride, doesn't affect electrical properties or insulation, 8-, 3-, 2-oz. sizes. Large size includes wall mount



and nonbreakable, pliable spray aid for pin-point applications and difficult places.— **Chemtronics, Inc.,** 122 Montgomery St., Brooklyn, N. Y.

MINIATURE TOGGLE SWITCH handles up to 100% overload beyond rated 5 amps, 115 volts ac. Designed for use with microminiature components, measures ½ x ⅜ x ¼ in.



Life-cycle rating 100,000 operations, contact resistance 30 microhms, insulation test 100,000 megohms, breakdown voltage 1,000 volts ac. Spdt and dpdt models.—**Alco Electronics,** 3 Wolcott Ave., Lawrence, Mass.

PICTURE-TUBE TESTER *model TV X 759* reads tube beam current, not just cathode emission. Meter indicates 0–400 μa in red, 400–600 μa in yellow. Shorts and leaks 1 megohm down are indicated. All standard pic-

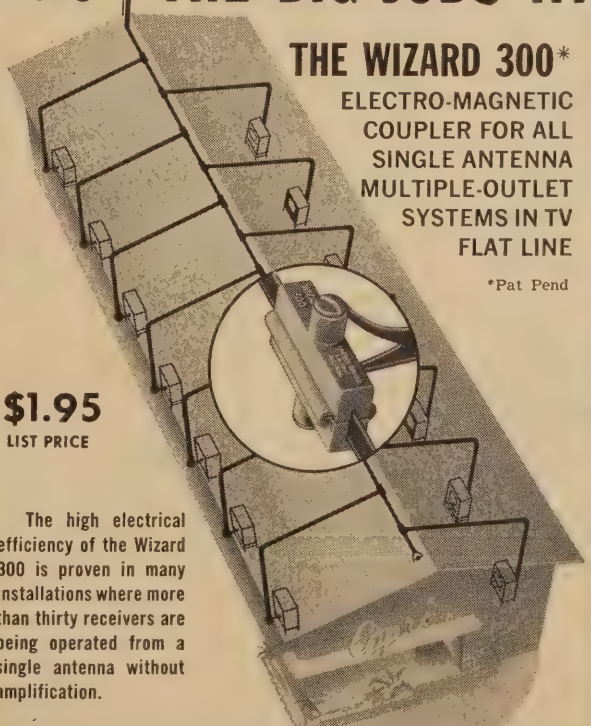
ture tubes handled, including 110° types (with adapter).— **Imperial Electronic Sales, Inc.,** 250 Montgomery St., Shreveport, La. END

All specifications on these pages from Manufacturers' data.

YOU CAN ALSO DO THE BIG JOBS WITH WIZARDS

HOME – 7 Outlets – One Antenna – No Amplification: Residence of Bob Barker, MC of the popular daytime NBC show Truth Or Consequences.

HOTEL – 120 Outlets–One Antenna–One Amplifier: The Montecito – 6650 Franklin, Hollywood, California.



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*Pat Pend

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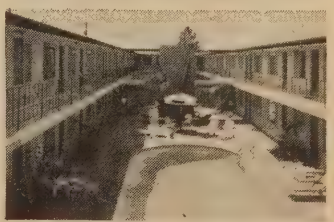
The high electrical efficiency of the Wizard 300 is proven in many installations where more than thirty receivers are being operated from a single antenna without amplification.

Information on any of the above jobs and a brochure covering Wizard System installations is available. Write Dept. RE-129.

CHARLES ENGINEERING, INC.
6053 Melrose Avenue • Los Angeles, California

HOUSING PROJECT – 2,549 Wizards Installed To Date: L.A. Housing Authority, Los Angeles, California.

APARTMENT – 39 Outlets–One Antenna –No Amplification: The Del Rio – 10236 Old River School Road, Downey, Calif



APARTMENT–48 Outlets–Two Antennas (24 Outlets each) – No Amplification: The Paramount Riviera – 12447 Paramount Blvd., Downey, California.

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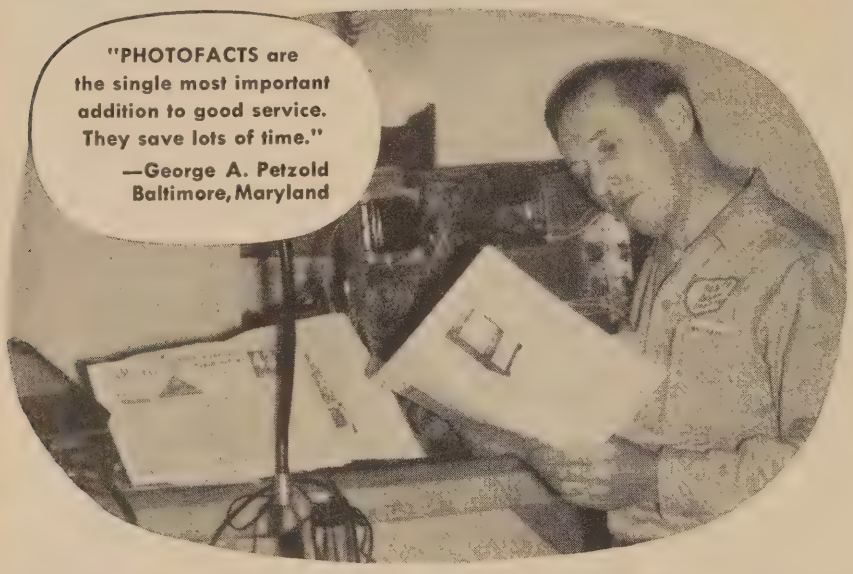
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—George A. Petzold
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Yes, the truly successful Service Technicians are those who own the complete PHOTOFACT Library, who can meet and solve any repair problem—faster and more profitably. And these men *keep ahead* because they're on a Standing Order Subscription with their Distributors to receive all new PHOTOFACTS as they are released monthly. (They're eligible for the benefits of membership in PEET, too—see below!)

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TECHNICIANS' NEWS

CALIF. GROUP INSURANCE PLAN

CSEA (California State Electronics Association) continues past the 30-member mark. A major factor appears to be its growing insurance package for members. Already set is a health insurance plan which pays $500 hospital expenses ($50 deductible), 80% over $500, and 80% of medical expenses. Also included are $1,000 life insurance and $1,000 accidental death benefits.

Business manager James Wakefield said that workmen's compensation would be the next part of the CSEA-sponsored insurance setup.

ARE YOU ON THE LIST?

Radio-Electronics is publishing a detailed list of the known television service associations in North America. If you belong to an association that isn't on our list or want to get the name and address of the one closest to you, drop a postcard to: Association Editor, Radio-Electronics, 154 West 14 Street, New York 11, N.Y.

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FALSE ADS KEEP SHOP OUT

The *TV Service Newsletter* of the Independent TV Service Dealers Association of Los Angeles County, Inc. reports that an application for membership was recently voted down because advertising run by the service dealer was considered undesirable. "The membership application submitted by ..... TV Service was rejected and the treasurer ordered to return the initiation fee submitted.

"While this applicant had a clean record with the BBB and the Los Angeles Police Department's Bunco Squad, his advertising was of such a nature that his membership is not considered desirable. Our secretary discussed the matter with the applicant, who refused to make the changes [in his advertising] suggested.

"It is not the policy of the ITVSDA to try to destroy the individuality of any ethical method of operation by a shop, but limits must be drawn somewhere. In this case it was the opinion of the board that the applicant could not possibly fulfill the claims and/or offer made in his ad, and therefore his advertising was not ethical."

TESA–MILWAUKEE LOOKS AT APPRENTICE PROGRAM

TESA–Milwaukee is considering some sort of apprenticeship plan which would take students or graduates from the local Milwaukee Vocational School and give them on-the-job training. *TESA News* pointed out that "the TV service industry is in need of good technicians; students who have had 2 years of day school training or 4 years of night school training would make ideal material. Such students have a good theoretical background and generally need only the experience of the shop and field service to make them into well rounded TV service technicians...."

TV TECH ACQUITTED

A San Bernadino TV technician was acquitted in Municipal Court there after being charged with fraud in the repair of a TV set. Two similar cases against other men were dismissed.

The Radio–TV Technicians Association collected information on the basis of repairs allegedly made on "gimmicked" sets. The city then charged the three men. The judge released them because he was "impressed" when one of the technicians performed a repair in court which two expert electronic instructors had told him could not be done.—**Scott Radio Supply Radiogram, Long Beach, Calif.**

LICENSING ALTERNATIVE

W. C. Pecht, editor of *TEAM* (Mo.) *News*, writes, "Now that I've said I'm agin it (licensing), it behooves me to offer an alternative to it. . . . So here are a few:

"Stop knocking your competitor; make competition, don't just meet it; improve your technical ability and your management methods; improve your public relations by recognizing the fact that the customer pays the bills, treat him as such; strengthen the associations by increased membership and attendance at meetings; adopt an advertising code of ethics and protect it; seek a method of voluntary certification, publicize it and the code of ethics; support and cooperate with local distributors; dress and act like a reputable technician and business man; protect the name of your competitor as though it were your own.

"Just as a license itself cannot cure every ill of the industry, the alternative cannot be a thing in itself; it must be many things. . . ."

MONEY-MAKING MAN

From the *TESA* Milwaukee *News:* "How can I make a better living in TV service? If your shop is average, you have about $600 invested in technical literature and less than $5 in books on business management. . . . Any boy can be a technician; it takes a man to make money doing it. . . . TESA meetings provide you with an opportunity to learn successful business techniques. There probably is no other place you can learn so much so quickly.

"I would like to cite John Lukich, of Lukich TV, as an example of those who learn at our meetings. John has been a member for only a year. But has doubled his income in that year. John is willing to share this information with anybody. Call him for the best testimonial on what he learned."

KC REPLYS TO TEAM SUIT

The City of Kansas City, its Mayor, the Chief of Police and the Commissioner of Revenue denied that the recently enacted technician-licensing ordinance violates either the Federal or State constitution. This was in answer to a suit against the city and its officials by two members of TEAM (The Electronic Association of Missouri) seeking to invalidate the law.

TSA–Kansas City, NATESA affiiliate, entered the case as a friend of the court to support the ordinance.

CERTIFICATION IN B.C.

First step toward certification of service technicians in British Columbia is a voluntary written and bench examination; successful technicians get a certificate showing they've passed. Before taking the exam, a man must prove he's been active in the trade for 4 years.

The Provincial Department of Labour in Vancouver, B. C., writes, "We have just finished administering the examination to a small group and so it is too soon for anyone to analyze the benefits or limitations of the project..."

The department set the program up at the request of technicians' groups seeking increased recognition and improved technical standards.

TOO MANY TV TECHS?

From the *Mo-Kan News* comes this provocative discussion, ". . . how is it that you can't hire a good bench man at the drop of a hat? Why can't you hire them at the snap of your finger if there is an oversupply? Some shop owners say there is a definite shortage of good men. The question is what constitutes a good man?

". . . in 1948 there were only 200,000 TV sets in the whole country. It is hard to say how many technicians there

NEW IMPORTANT SAMS BOOKS

"TV Servicing Shortcuts"

by Milton S. Kiver

ALL-NEW EDITION! Famous best-seller, completely revised, more valuable than ever. Helps the technician sharpen his service techniques by use of the case-history method. Shows through-69 case histories how to quickly solve commonly recurring TV service problems. Outlines trouble symptoms; gives step-by-step explanation of how to track down, localize and solve the trouble in any TV set. Includes a number of transistor and printed-board servicing problems. A truly invaluable trouble-shooting guide. 104 pages; 5½ x 8½". *Only*..... **$1.50**

"ABC's of Ham Radio"

(How to get your novice license)

by Howard S. Pyle

Here's all you need to know to qualify for the radio amateur novice license. Written by an expert, formerly a government License Examiner, and teacher of a course on the subject. Includes typical questions from novice exams to illustrate points. Chapters include: About the Exam; The Radio Telegraph Code; Basic Electricity; Radio Power Supplies; Electrical Measurements; The Radio Transmitter; Legal Aspects of Operation; Examination Procedure; You're On the Air; etc. Best book of its kind—written so everyone can understand it. 112 pages; 5½ x 8½". *Only*..... **$1.50**

MORE NEW BOOKS

"Two-Way Mobile Radio Handbook"

Author Jack Helmi presents the first really comprehensive treatment of the subject of mobile radio. Ten complete chapters cover: basic systems; types of receivers available; transmitters; control systems; antenna systems; power; servicing of mobile radios; etc. Written especially for those who service, install and maintain mobile equipment. 240 pages; 5½ x 8½". *Only*..... **$3.95**

"Servicing TV Video Systems"

The third volume in Jesse Dines' series of comprehensive TV circuit coverages: Discusses operation of the video-IF amplifier, video-detector, video-amplifier, and the picture-tube stages of a TV receiver. Includes data on color sets and recent changes in video systems. Really helps you master the modern video system; gives you trouble-shooting know-how, helpful servicing hints, methods for improving fringe area reception, and picture tube substitution data. Owners of Dines' previous books ("Servicing TV Sync Circuits" and "Servicing TV Sweep Systems") will want to add this valuable book to their library. 264 pages; 5½ x 8½". *Only*..... **$3.95**

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0Z4	.59	6BQ6	1.19	12AX7	.79	3D23	3.85
1A7	.89	6BZ7	1.25	12BA6	.65	717A	5/$1
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1R5	.78	6C5	.69	12BD6	.59	4-250	35.00
1S4	.78	6CB6	.80	12BE6	.59	4E27	7.00
1T4	.78	6CD6	1.49	12BF6	.59	4PR60	29.50

Send $2c for Catalog!

1U4	3/$1	6H6	3/$1	12BH7	.99	4X150G	$15
1U5	.73	6J5	.52	12BY7	.98	4X250	35.00
1X2A	.98	6J6	.48	12BZ7	.99	4X500	38.00
3Q4	.68	6K6	.59	12CU6	1.45	5BP1	4.98
3Q5	.86	6K7	.74	12SA7	.94	5BP4	4.98
3S4	.68	6L6	1.19	12SG7	.89	35T	4.00
3V4	.83	6S4	.59	12SH7	.89	100T	7.00
5R4	.98	6S8	.99	12SJ7	.75	316A	5/$1
5U4	.99	6SA7	.69	12SK7	.94	388A	3/$1
5V4	.89	6SB7	1.19	12SQ7	.84	416B	16.00

Wanted Surplus Electronics from schools & U

5Y3	.59	6SC7	.89	19BG6	2.15	450T	42.00
6AB4	.59	6SG7	.79	19T8	1.06	807	1.00
6AC7	.70	6SH7	.69	25BQ6	1.39	809	3.00
6AG7	.89	6SJ7	.69	25L6	.69	811A	4.40
6AH6	.99	6SK7	.73	25W4	.77	812	3.50
6AK5	.69	6SL7	.89	25Z5	.63	813	9.00
6AL5	2/$1	6SN7	2/$1	25Z6	.75	814	3.45
6AQ5	.63	6SQ7	.74	EL34	3.49	815	2.75
6AS7	3.00	6SR7	.75	EL37	2.49	826	.50
6AT6	.49	6T8	.98	35L6	.69	829B	8.00

Wanted 304 tl tubes! Top $ $ Paid

6AU4	1.10	6U8	.98	35W4	.49	832A	7.00
6AU5	1.19	6V6GT	.70	35Y4	.69	866A	2.75
6AU6	.69	6W4	.79	35Z5	.63	1625	5/$1
6AX4	.79	6W6	.89	50A5	.69	6146	4.00
6BA6	.59	6X4	2/$1	50B5	.69	5879	.98
6BA7	1.00	6X5	.49	50C5	.69	5881	2.70
6BD6	.69	6Y6	.97	50L6	.69	6550	3.90
6BE6	.59	7N7	.89	KT66	3.29	5654	1.00
6BG6	1.50	12AL5	.59	75	.89	5894	12.00
6BH6	.72	12AQ5	.75	80	.59	7193	10/$1

TUBES WANTED! WE BUY! SELL & TRADE!

NEW "TEKSEL" SELENIUM RECTIFIERS

FULL WAVE BRIDGE RECTIFIERS. *ONE YEAR GTD!*

AMP. CONT.	18VAC 36VAC 14VDC 28VDC	72VAC 56VDC	144VAC 118VDC
1AMP	$ 1.30 $ 2.00	$ 4.90	$ 9.45
2AMP	2.15 3.00	6.25	12.30
3AMP	2.90 4.00	8.60	16.75
6AMP	4.15 6.00	18.75	36.15
10AMP	6.10 12.15	26.30	48.90
15AMP	9.90 19.00	40.00	66.60
24AMP	15.00 29.45	57.50	108.45

NEW SILICON 500MA RECTIFIERS LO PRICED GTD!
Input Working Range RMS/ACV Res. or Cap.

rms/piv 35/50 30¢	rms/piv 70/100 45¢	rms/piv 140/200 50¢	rms/piv 210/300 65¢
rms/piv 280/400 78¢	rms/piv 350/500 $1.00	rms/piv 420/600 $1.26	rms/piv 490/700 $1.50
rms/piv 560/800 $1.59	rms/piv 630/900 $1.89	rms/piv 700/1000 $2.58	rms/piv 770/1100 $3.12

Use in Bridge or C.T. up to 750ma dc

General Purpose 400PIV @ 250Ma Special 2 for $1; 25 for $10. **PPd. 48 states TopHats only!*

YOUR BEST BUY! "TAB" FOR BARGAINS

2N277 $4.50; 2N278 $5.50; 2N441 $3; 2N442 $5; "IRISH" TAPE 1200' BEST GRADE $159 @. 6 for $9; "IRISH" TAPE 2400 Ft. MYLAR BEST GRADE $4.49, 3 for $12; SNOOPER SCOOPER 2" $5 @ 2 for $9; 4x150 HiTemp. CHIMNEY EZ Mtg. 75¢; BC221 NEW ORIG. SIG CORPS RECALIB & RECONDITIONED OVSEAS PCKD NEW CALIBRATION BOOK MINT COND!! $110; NEW BC1335A 25 to 38.8 Mc's TRANSCEIVER WITH 6&12V SUPPLY & SPARES **OVSEAS PCKD** $89; RDZ-USN 200-400Mc's RCVR Less Tubes $25; AN-ARR2 RCVR GOOD COND less tubes $1.59. SEND FOR NEW CATALOG 25¢.

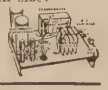
DC POWER SUPPLIES for TRANSISTORS!

New low-cost filtered 0.5% Ripple Power Supply. Same as specified in Transistor Manual **G.E.** Ideal for Powering transistor circuits, small in size!

12 VDC at 150 Ma-T12V150M.....$ 8

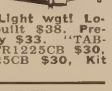
25 VDC at 150 Ma-T25V150M.....$10

40 VDC at 1 Amp-T40V1A.....$19



TRANSISTORIZED DC POWER! HI-EFFICIENCY DC to DC to 450 VDC "TABSTAT" KIT or BUILT!

Output 450 & TAP 250VDC at up to 150 MA/Up to 70 Watts 80% efficiency: ripple 0.2%; low idle current one amp silicon rectifiers, oil condensers, toroid trans. fused & short circuit proof. Regulation 5% at 20 to 100% load!! **Small in Size! Quiet! Light wgt! Lo-priced** qtd "TABSTAT" TR1245CB built $38. **Pre-Assembled U-Build kit TR1245CK only $33.** "TABSTAT" 250VDC @ 100MA/12V in TR1225CB **$30.** Kit TR1225CK **$27,** 6V inpt TR6125CB **$30,** Kit TR625CK **$27.**



KITS! "TAB" *THE BEST KITS!*

All Kits Contain Most Popular Values & Sizes

Kit 2 Eng. Paralle! Rules	Kit 5 Sub-Min Tubes
Kit 35 Precision Resistors	Kit 40 Stand-Off Insulators
Kit 10 Switches	Kit 35 Power Resistors
Kit 75 Resistors ½/1½W	Kit 75 Mica Condensers
Kit 150 Carbon Resistors	Kit 5 Crystal Diodes
Kit 25 Panel Lamps	Kit 100 Fuses, Assorted
Kit 12 Electrolytic Cond's	Kit 100 Ceramic Condsr.
Kit 56 Tube Sockets	Kit 10 Germanium Diodes
Kit 65 Tubular Cond'sers	Kit 5 FT243 Xtal Holders
Kit 500 Lugs & Eyelets	Kit 8 Silicon Diodes
Kit 10 Bathtub Oil Cond's	Kit 5 Microswitches
Kit 5 lbs. Surprise Pckg.	Kit 4 Asstd Rectifiers
Kit 10 Xmttr Mica Condsr.	Kit 2 PNP Transistors
Kit 3 Phone/Patch Xfmrs	Kit 4X50 Ft Hookup Wire
Kit 3 Searchlights	Kit 2 Veeder Counters
Kit Circular Slide Rule	Kit 2—Computer Toroids
Kit 12 Algtr Clip Asst'd.	Kit High Gain XTAL Mike

BUY 10 KITS—GET ONE FREE! **EACH KIT 99¢**

"TAB" TERMS: Money Back Guarantee! One 15th year. $2 min. order F.O.B. N.Y.C. Add shpg charges or for C.O.D. 25% Dep. Prices shown subject to change.

111-GF LIBERTY ST., N.Y. 6, N.Y.

Send 25c PHONE: RECTOR 2-6245 *for Catalog*

were, but 1 year later there were five times as many sets. Were there five times as many technicians? By 1950, we had four times as many sets as in 1949, and 20 times as many as in 1948. We don't know if there were 20 times as many technicians in 1950 as 2 years before, but we doubt it. By the end of 1958, there were over 200 times as many TV receivers in use as in 1948. Were there 200 technicians by then for every single one only 10 years earlier?

"In 1948 there were no transistor radios and the record player business was only a fraction of what it is today. Many of our customers today have two or more TV sets. Hospitals, hotels and motels have them in abundance.

"Whether there are too many service technicians is certainly a controversial question. However, most people admit there is a need for good men . . ."

SENDING BOYS TO DO MEN'S . . .

Shortage of TV technicians is causing Los Angeles service dealers to recruit high school students as repair technicians, according to a report in *Home Furnishings Daily.*

Milton Aller, of Tops TV & Hi-Fi, said that TV technicians were being drained off by industry. Another prominent service dealer, Murray Gibin, Universal TV Co., Inc., said the trouble stemmed from manufacturers who educate the public to expect troublefree sets. As a result, retailers cannot include service charges in sales prices, the customer is unhappy about service costs and the service dealer has to try to get whatever service personnel he can.

ESFETA ELECTS

Empire State Federation of Electronic Technicians Associations, Inc. elected new officers and voted to accept a new association from St. Lawrence County, increasing its membership to 15 associations.

Incoming officers are Irving Toner, president; Robert Henderson, vice president; O. Capitelli, secretary; Mel Cohen, corresponding secretary.

KNOXVILLE TECHS FORM GROUP

More than 30 TV service dealers have applied for membership in a newly formed service association which hopes to "eliminate misrepresentation by marginal service companies."

The BBB (Better Business Bureau) cooperated with radio–TV people in the formation of the group, which elected Lonnie Dispennette, of the local Sears Roebuck TV service department, president.

DON'T DO-IT-YOURSELF!

A parts jobber in Detroit, Mich., takes local ads saying, in part, "Open Letter To TV Set Owners—You

FIX OLD RADIOS IN A JIFFY!

Fix 'em good as new . . . without lost time or needless testing

Often, it takes more time than it's worth to fix old radios . . . but NOT when you own this 3½-pound, 744-page RADIO TROUBLESHOOTER'S HANDBOOK! Just look up the old make and model. Handbook tells exactly what is likely to be wrong—shows **exactly how to** fix it. No wasted time. No needless testing. Gives common trouble symptoms for over 4,800 old home receiver models, auto radios, and record changers made from 1925 to 1942 by 202 manufacturers. Includes old tube and component data no longer available from any other source.

CUT SERVICE TIME IN HALF!

Even beginners can repair old sets which might otherwise be thrown away because service data is lacking! Handbook more than pays for itself first time you use it! Covers old sets made by Airline, Apex, Arvin, Atwater Kent, Belmont, Bosch, Brunswick, Clarion, Crosley, Emerson, Fada, G-E, Kolster, Majestic, Motorola, Philco, Pilot, RCA, Silvertone, Sparton, Stromberg and dozens more. The only service guide of its kind still in print.

10 DAY FREE EXAMINATION

Dept. RE-30, RINEHART & CO., Inc.
232 Madison Ave., New York 16, N. Y.

Send RADIO TROUBLESHOOTER'S HANDBOOK for 10-day examination. If I decide to keep book, I will then send $6.95 plus postage. Otherwise, I will return book promptly and owe you nothing.

(SAVE! Send $6.95 with order and we pay postage. Same 10-day return privilege with money refunded.)

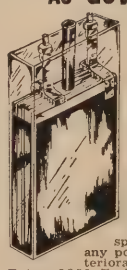
Name.....

Address.....

City, Zone, State.....

OUTSIDE U. S. A.—Price $7.45 cash with order only. Money back if you return book in 10 days.

THE BATTERY THAT'S USED IN GUIDED MISSILES NOW RELEASED AS GOVERNMENT SURPLUS



For Photography, Aircraft, Models, Searchlights, Radios, etc.

$1.95 EA. Postpaid

Sintered-plate Nickel-Cadmium alkaline storage batteries designed for "NIKE" Missile and now surplus due to design change. A lifetime battery with no known limit of service (over 5000 recharges on test without loss of capacity). Other features: Virtually indestructible, compact & lightweight, withstands heavy shock and vibration. Flat voltage curve during discharge retains charge year or more, high discharge rate up to 50 amps. for this cell, no corrosive fumes to harm clothing or equipment. spill-proof construction, discharge in any position, indefinite storage without deterioration, operates in temperatures —60° F to +200° F. Each cell is approx. 4 ampere hour capacity. Nominal voltage per cell is 1.2 volts. (A 6 V. battery requires 5 cells.) Cell size 6" H. x 2" W. x 1½" T. Wt. 6 oz. ea. Uses Potassium-Hydroxide (30%) electrolyte. Negligible loss during lifetime service. Add only distilled water once a year. A fraction of Government cost.

Used Test Cells.....**$1.95** ea. Postpaid
Brand New Cells.....**2.95** ea. Postpaid
24 V. Battery, (20 cells in metal case) used $40, new $60.

ALL CELLS GUARANTEED TO YOUR SATISFACTION OR MONEY REFUNDED (LESS POSTAGE).
Plastic battery cases may have slight cracks. Repaired easily with household cement. Or you may add 25¢ to price of each to insure uncracked case.

ESSE RADIO COMPANY, Dept. M-6
42 W. South Street **Indianapolis 25, Indiana**

Please mention
RADIO-ELECTRONICS
when answering ads.

BEST IN HI-FI VALUES!

NO DELAY SERVICE

All orders rushed to you in factory-sealed cartons.

Write for free catalog.

audion **25-E Oxford Road Massapequa, New York**

wouldn't take a doctor's prescription to a hardware or grocery store—yet many people take their TV tubes to such places *in the mistaken belief* that they can find their troubles. . . . This practice is costing the general public thousands of dollars annually in replacement of tubes that may not need replacing."

WANTS JOBBERS CLOSED ON SATURDAY

TESA–St. Louis reports a letter saying, "A lot of dealers want the parts distributors to close Saturdays. The dealers say that having them open on the weekend lets too many tube sales and other items go to the distributors when they should go to dealers.

"I for one would like to see them close on Saturdays. How about all dealers getting together and asking the distributors to close on Saturdays?"

ANTENNA FOULS POWER LINE

In Carbondale, Pa., an improperly installed TV antenna fell onto public-utility power lines, disabling electrical power service in 450 homes for several hours. All lights and refrigerators were out of use during the mishap. The power lines fell down on a dairy truck, but no one was injured.

Subsequently FRTSAP (Pennsylvania Federation of Radio & TV Service Associations) voted to present standards of antenna installation and maintenance to the state and to utility companies. The group is pressing to incorporate the standards into the technician licensing law. They'd also like to see antenna installations inspected by an Underwriters group.

NATESA URGES SELECTIVE BUYING

The National Alliance of Television & Electronic Service Associations called on its members, during its Chicago convention to buy parts only from manufacturers who do not compete with the independent service technician. NATESA delegates also resolved to recognize only the standard 90-day warranty on parts and tubes and 1 year on picture tubes. No factory labor warranty is to be recognized. Finally, the group asked manufacturers to register all TV sets by number and issue numbered registration certificates to owners. Comment from set makers held out little hope of accomplishing this last request.

TEXAS TECHNICIANS' PAY

The US Department of Labor has released a survey dealing with the pay structure in TV service shops in Dallas, Tex. It found that the average gross pay for bench technicians was $81.50, for outside men $75.50. The highest-paid group included the men who worked both at the bench and outside. They averaged $92 a week. END

2" to 14" blades, 4 bit sizes. Available with shock-proof plastic covered tubing.

Ask For It At Your Dealer

KEDMAN CO., 233 S. 5th W., Salt Lake City, Ut.

LOOKING?—you stand a better chance of finding what you want if you advertise in

RADIO-ELECTRONICS Opportunity Adlets.

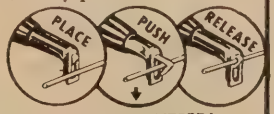
See details on Page 135

"LESS WORK HOURS — MORE MONEY with E-Z-HOOK!"

Jed Motz
Audio Engineer, Cincinnati, Ohio

"In my business of designing and building Hi-fi equipment, I've saved many hours of work using E-Z-Hook Test Connectors.
NO MORE SOLDERING or unsoldering wires when I use E-Z-Hook Sub Connectors to connect component parts in experimental setups and breadboarding. They connect and disconnect so easily and I'm always sure of quick, positive connections.
WHEN CHECKING out circuits, I save lots more time, too, with E-Z-Hook Tips and Clips. Hooking up the Scope, Meters, Speakers, etc., with these self-holding connections, leaves my hands free. And, since they can't pull off, I don't have delays and aggravations caused by loose intermittent test connections that used to jump off and short. Believe me, the hours I saved put dollars in my pockets."

EXCLUSIVE E-Z-HOOK DESIGN!



EASY TO USE! GUARANTEED!

The self-adjusting stainless steel hook and nylon insulator clamps firmly in even hard-to-reach places. Eliminates loose intermittent connections and adjacent shorts.

AT YOUR FAVORITE PARTS DISTRIBUTOR
From 49¢ up

E-Z-HOOK TEST PRODUCTS — SAFE • FAST • SURE

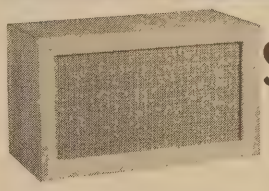
ORDER THROUGH YOUR PARTS DISTRIBUTOR

E-Z-HOOK TEST PRODUCTS
Dept. G3, 1536 Woodburn Ave.
Covington, Ky.

Canadian Rep. Len Finkler Ltd., Toronto, Ont.

ORDER YOUR ENCLOSURE KITS FROM HOMEWOOD

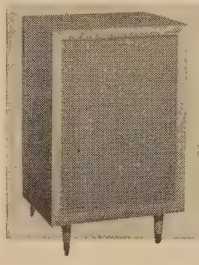
Bring out the best in your speakers . . . save dollars in assembly and finishing costs . . . get the fun of "doing-it-yourself"!



ONLY **$11.95**

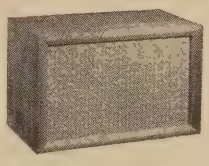
MODEL 6

Factory assembled, ready for finishing. Makes your 8" speaker sound like a million! Made of ½" hardwood ply, beautifully grained and smoothly sanded. 10" h. x 16" w. x 9" d. 9 lbs. Order two for matched stereo performance.



MODEL 1

4½ cubic feet of baffle space assures you crispest, cleanest bass response from any 12" speaker system. Full-grained white birch ply, with pre-attached bracing cleats for easy assembly. Kit includes **everything** you need for assembly. 29" h. x 20" w. x 12½" d. (5" legs). 25 lbs. **$18.95**



MODEL 2

Clear-grained on four sides for bookshelf or floor use. Acoustically accurate for 12" systems, with adapter board for 8" speakers. Sturdy, ¾" ply eliminates unwanted resonances, improves bass response. 14" h. x 21" w. x 11¾" d. 20 lbs.
In Birch, **$14.50**
In Walnut, **$19.95**

MODEL 13. Finishing kit; includes generous quantities of everything you need to do a professional, long-lasting finishing job, plus brush, sandpaper and easy-to-follow instructions. Specify: Mahogany, Walnut, Blonde, Oak, Fruitwood, Maple, Cherry, Ebony, Natural. **$3.89**

Ten-day money-back guarantee. All items shipped freight collect. Please send check or M.O. (No COD's)

HOMEWOOD INDUSTRIES, Inc.
26Y Court Street, Brooklyn 1, N.Y.

Please send me:
( ) Model 6 ( ) Model 1 ( ) Model 2 (Birch) (Walnut)
( ) Model 13_____
( ) Homewood catalog
I enclose remittance in the amount of $_____

Name_____

Address_____

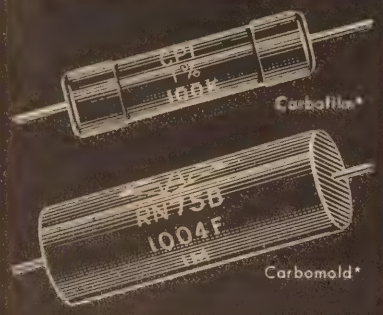
City_____ Zone____ State_____

GERNSBACK LIBRARY

Low-cost, paper-covered books on all phases of TV, radio, audio-high fidelity and practical electronics

ON SALE AT ALL BETTER PARTS DISTRIBUTORS

PRECISION PERFORMERS



carbon-deposited
RESISTORS

When the application calls for accuracy and stability you'll find Aerovox Precision (±1%) Carbon-Deposited Resistors fill the bill perfectly. Manufactured under exacting quality control specifications to assure excellent performance even under adverse operating conditions.

CARBOFILM RESISTORS . . . for wide use in circuits where accuracy and economy are factors. Units are protected by a specially formulated Aerovox coating against environmental conditions. Stocked in 300 values in following ratings:

Type	Sizes	Min. Ohms	Max. Meg-ohms
CPS-½ watt	0.162D x 13/32L	7	2
CP-½ watt	0.230D x 1 1/16L	3	5
CPL-½ watt	0.230D x 1 3/4L	5,100,000	7.5
CP-1 watt	0.293D x 1 3/4L	10	15
CP-2 watt	0.293D x 2 1/16L	50	100

CARBOMOLD RESISTORS . . . encapsulated in a strong reinforced moisture and heat resistant plastic these units offer new standards of reliability. Over 500 standard values available from stock as follows:

Type	Sizes	Std. Min. Ohms	Std. Max. Meg.
CPM-½	¼ x .735	10	2.49
CPM-1	3/8 x 1 3/32	10	5.11
CPM-2	3/32 x 2 7/32	30	10

All units marked with type number, RN Number, value and tolerance. Available for "off-the-shelf" delivery from your local Aerovox Distributor.

AEROVOX CORPORATION
DISTRIBUTOR DIVISION
NEW BEDFORD, MASS.

Trademark

new PATENTS

REDUCING RECOVERY TIME

Patent No. 2,894,152

Richard L. Anderson, Syracuse, N. Y. (Assigned to IBM, New York, N. Y.)

Recovery time is the interval required before a conducting diode can be made to block. It is a disadvantage which limits a diode's high-frequency response.

Here a metallic surface is coated or soldered

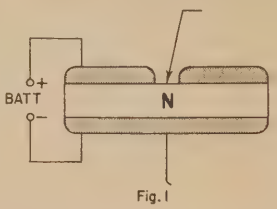


Fig. 1

to the diode (Fig. 1), leaving only a small opening for the point contact. A dc bias is impressed across the diode to remove positive carriers from the semiconductor. This leaves

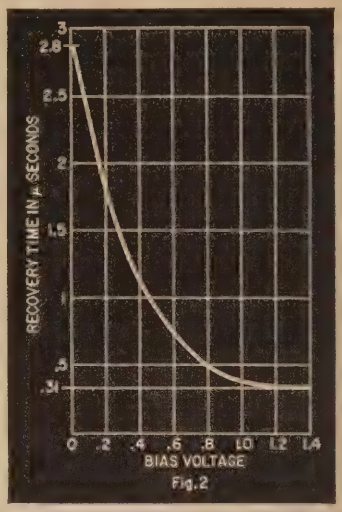


Fig. 2

few charges to carry a flow when blocking bias is applied.

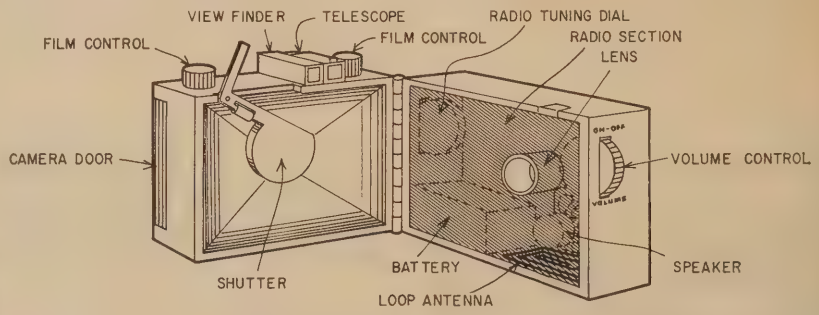
In a typical diode, 2.5 mm square and 0.75 mm thick, a 1.4-volt bias reduced recovery time from 2.8 to 0.31 μsec (see Fig. 2).

CAMERA-RADIO-TELESCOPE

Patent No. 2,899,879

Rene Lopez, New York, N. Y.

A single box carries all three of these items: camera, radio and telescope, making it ideal for picnics, vacations, sports. The radio and camera



lens are mounted in the right-hand section of the hinged box (see diagram). The left portion carries the camera and telescope. When the box is closed, the lens fits into place in front of the film. When the handle is swung sideways, it opens an aperture and allows light to pass through the lens to expose the film.

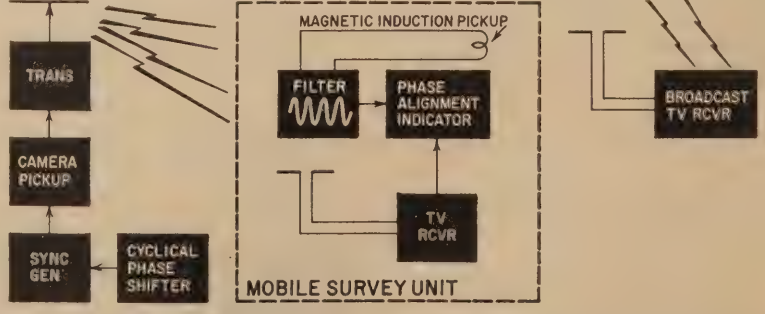
A hinged door permits access to the film compartment when necessary. The telescope is mounted alongside the camera viewfinder next to the film control.

AUDIENCE SURVEY SYSTEM

Patent No. 2,903,508

J. L. Hathaway, Manhasset, N. Y. (Assigned to RCA)

This invention makes it possible to find out the channel to which a TV receiver is tuned, without ringing doorbells or phoning. A mobile unit moves past the house, and meters indicate



what the occupants are viewing. It works on the fact that when a receiving set is properly tuned, the phase of its horizontal sync frequency is synchronized with that of the transmitter.

The mobile unit tunes in the broadcast transmitter and also picks up radiation from the TV set (15.75 kc and harmonics). The respective pulses are clipped, broadened and combined in a phase comparator. Maximum output occurs only when the pulses are exactly in step.

Transmitters in the same area are generally synchronized with a common power source so to assure that each transmitter in the area has a distinct phase of its own, each should include some means for continuous phase shift at a slow rate.

END

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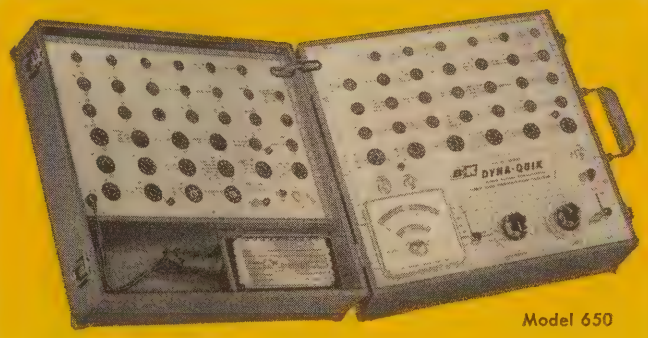

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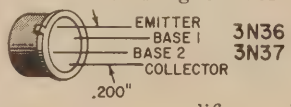
See Your Distributor or Send Now for Bulletin ST24-E

NEW TUBES and SEMICONDUCTORS

TUBES and semiconductors are about equally represented this month. We start off with two tetrode transistors, go on to a couple of TV tubes, touch on a solar cell and silicon-controlled rectifiers and close with another TV tube and a quartet of silicon transistors.

3N36, 3N37

Two germanium meltback n-p-n tetrode transistors designed for high-



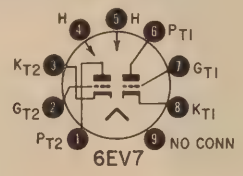
frequency use as an amplifier, oscillator or mixer. The 3N36 is recommended for use in the frequency range from 30–100 mc; the 3N37 for 100–200 mc. Both make good wide-band video amplifiers from low frequency to 10 mc.

Absolute maximum ratings of these General Electric tetrode, transistors at 25°C. are:

V_{CB} (either base)	7
V_{EB} (either base)	2
V_{CE}	6
I_C (ma)	20
I_E (ma)	20
I_{B2} (ma)	2
P_{total} (mw)	30

6EV7

A high-mu twin triode in a 9-pin miniature envelope designed for use as



a relay-control tube in remote-control tuning units of TV receivers.

The tube is processed for long periods of operation under standby (plate-current cut off) conditions. It features slotted micas to assure low interelectrode leakage, special cathode sleeve material to minimize cathode interface resistance and interelectrode leakage and a separate base pin for each cathode.

Maximum ratings of the RCA 6EV7 in relay control service (each section) are:

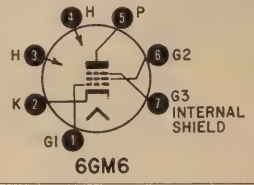
V_P	300
V_G (pos bias value)	0
I_K (ma)	20
P_P (watts when on time exceeds 30 seconds in any 2-minute interval)	2.5
(watts when on time does not exceed 30 seconds in any 2-minute interval)	4.5

In class-A1 amplifier service, the tube has a transconductance of 5,200 μmhos and an amplification factor of 60 (plate voltage, 250; plate current 9.2 ma.).

6GM6

A semi-remote-cutoff pentode in a 7-pin miniature envelope, designed for use as an if amplifier in gain-controlled picture if stages of TV receivers. The 6GM6 has separate base pins for grid 3 and the cathode. This permits the use of an unbypassed cathode resistor to minimize changes in input conductance and input capacitance with bias.

Characteristics of the RCA 6GM6



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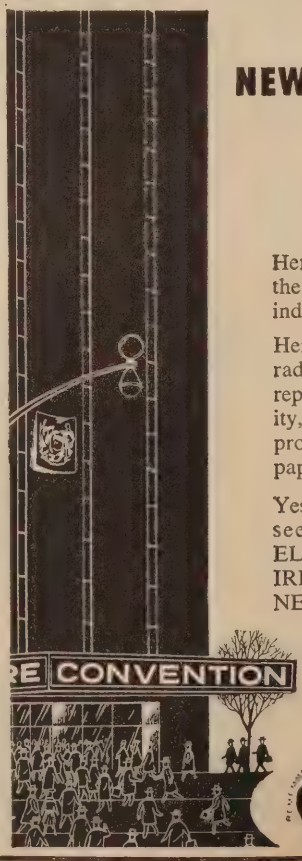

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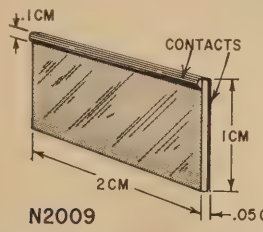
when used as a class-A1 amplifier are

V_P	125
G3 connected to cathode	
V_{G2}	125
R_K (ohms)	56
R_P (k ohms)	200
gm (μmhos)	13,000
I_P (ma)	14
I_{G2} (ma)	3.4

N2009

Silicon solar cells with 9% efficiency available as single cells or in ruggedized shingle arrays for space vehicles, missiles and industrial applications. The diffused-junction cells measure

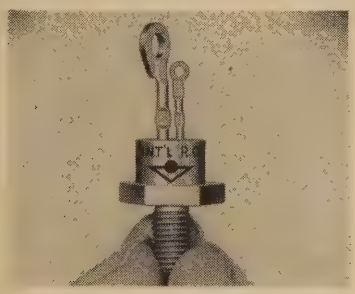


N2009

1 x 2 x .05 cm. The Texas Instruments N2009 will deliver up to 22.5 mw at 56.5 ma and 0.4 volt per cell when operated under sunlight levels found in near space. All cells have a silicon monoxide coating to reduce reflection losses. Glass covers can be provided to give increased emissivity in the 4–14-micron range. Cells have alloyed contacts for fabrication into multiple arrays.

X16RC2—X16RC20

Silicon-controlled rectifiers (thyrodes) for applications requiring load currents up to 16 amps and blocking voltages from 20–200, made by International Rectifier. This new series is capable



of controlling 16 amps of current in static switching, dc motor control, variable and regulated dc power supplies, welding control, ignition firing and similar switching applications.

The three-junction semiconductor unit switches rapidly to a conducting state when a signal is applied to its third (gate) terminal, or when its critical breakover voltage is exceeded.

6GN8, 8GN8

A high-mu triode and a sharp-cutoff pentode in the same 9-pin envelope. The triode section is designed for use as a voltage amplifier or sync separator. The pentode section features a controlled plate knee characteristic and is designed for video amplifier service. The 8GN8 has an 8-volt 600-ma heater with controlled warmup for series-string heater circuits.

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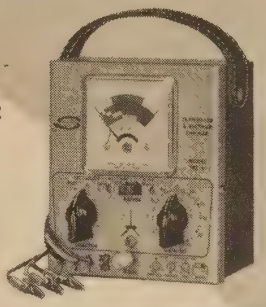

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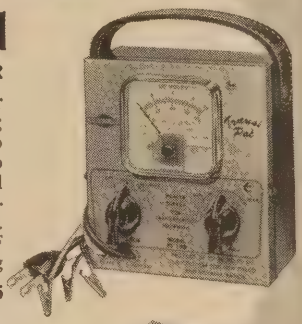
All-new "Transi-Pak," twin to TRC4 Checker above. Provides variable DC voltage to 24 volts; 1.5-volt biasing tap (a "must" for servicing Philco and Sylvania radios). Metered current output, to 100 ma. Handles 200-ma peaks. Two 200-mfd electrolytics provide proper filtering and low output impedance. No hum or feedback problems. Ideal for alignment using station signal; adjust IF slugs for max. current, also ideal for charging nickel-cadmium batteries. Size, 5x4½x2½". DEALER NET..... **17.95**



Find Defective Stage in a Minute . . .

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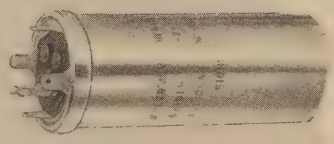

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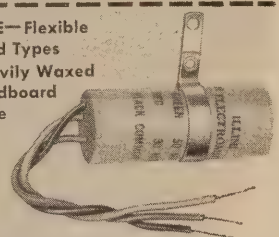
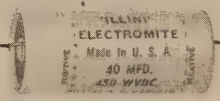


IHCE—Tubular Types Aluminum Case



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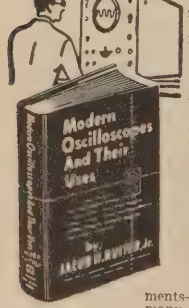

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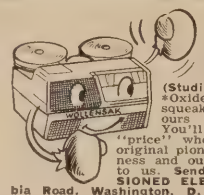

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6GN8
8GN8

Typical operating characteristics of the Sylvania 6GN8 and 8GN8 are:

	Triode	Pentode
V_P	250	200
V_{G2}	—	150
V_{G1}	−2	—
$R_{K\ bias}$ (ohms)	—	100
I_{G2} (ma)	—	5.5
I_P (ma)	2	25
gm (μmhos)	2,700	11,500
μ	100	—
R_P (k ohms)	37	60

2N1276, -77, -78, -79

A group of n-p-n silicon transistors for amplifier applications in the audio- and radio-frequency range and for general-purpose switching circuits. All

are grown-junction units with a diffused base.

Maximum ratings of these G-E units at 25°C are:

V_{CB}	40
V_{CE}	30
V_{EB}	1
I_C (ma)	25
P_C (mw)	150

Typical characteristics of these units are:

H_{fe} (V_{CB}=5, I_E=1 ma,	2N1276/-77/-78/-79			
f=1 kc)	14	33	66	101
NF (db)	22	18	15	15
G_e (pwr gain db) (V_{CE}=5, I_C=1 ma, f=1 kc)	37	39	44	45
$f\alpha_b$ (cutoff freq mc) (V_{CB}=20, I_E=1 ma)	30	30	30	34

END

50 Years Ago

In Gernsback Publications

HUGO GERNSBACK, *Founder*

Modern Electrics	1908
Wireless Association of America	1908
Electrical Experimenter	1913
Radio News	1919
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Short-Wave Craft	1930
Television News	1931

Some larger libraries still have copies of Modern Electrics on file for interested readers.

In March, 1910, *Modern Electrics*

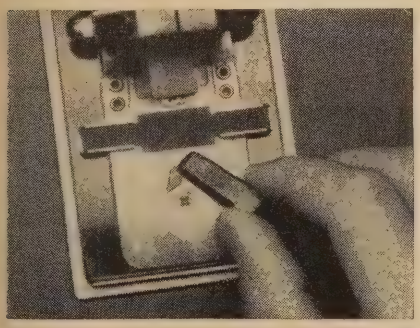
Condensers for the Production of Electric Oscillations, by William E. Smith.
Duplex Wireless Receptive System, by George F. Worts.
German Wave-Control Device, by the Berlin Correspondent.
The Peukert (High Frequency) Generator.
Pancake Tuner, by A. C. Marlowe.
Precaution Against "Kickbacks", by Cyril C. Lotz.
Helps for the Amateur.
Simplified Aerial Switch.

REPLACING SELENIUM RECTIFIERS

A good percentage of portable radio servicing entails replacing selenium rectifiers. The majority are 75-ma units which are operated close to their maximum current ratings. Many technicians would like to use 100-ma replacements to get a safety margin, but because of their larger physical size this cannot be done. I solved this problem by using 150-ma silicon diodes as replacements. These units can be installed as easily as a resistor. By stocking these 150-ma silicon diodes I have eliminated the necessity of stocking an assortment of selenium rectifiers for portable radios.—*Albert J. Krukowski*

TAPE-SPLICER CLEANING

One of the hardest cleanup jobs the tape-recording fan runs into is that of removing the tiny bits of magnetic tape that get stuck in the hinge of the splicer where they are likely to be caught in the splicing tape. The solution to the



problem is simple. Just use a small magnet (I salvaged mine from an ion trap) to pick the scraps of tape out of the splicer. The tape, of course, is magnetic and is attracted to the magnet. A word of caution: Demagnetize the splicer occasionally to avoid damaging valuable recordings.—*Ronald S. Newbower*

BOOST FRINGE RECEPTION

The small five-tube receiver in fringe areas needs a little boost for good reception. The schematic shows how to supply it. Very little cost or time is involved. The only parts needed are some hookup wire and a small variable capacitor. I took the variable capacitor from the rf stage of an old Army receiver. The plates on this little variable capacitor are the size of a dime.

Connect the little trimmer to the antenna section trimmer of the receiver's

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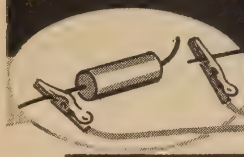

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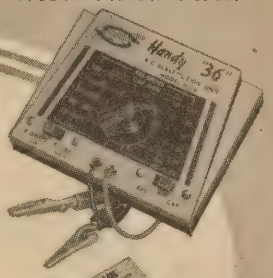

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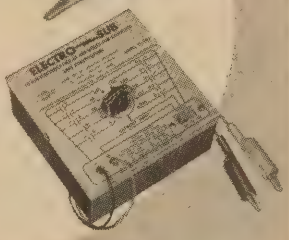

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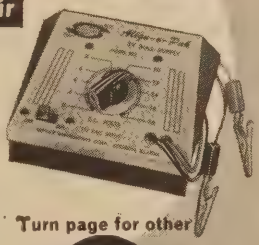

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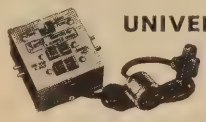

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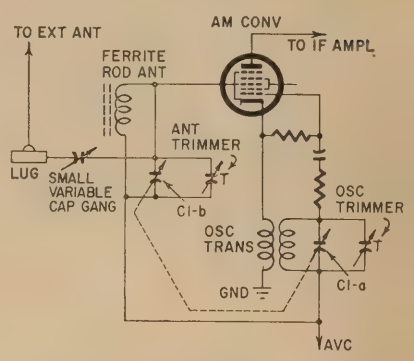


gang, and the other end to a floating lug located on the outside of the receiver.

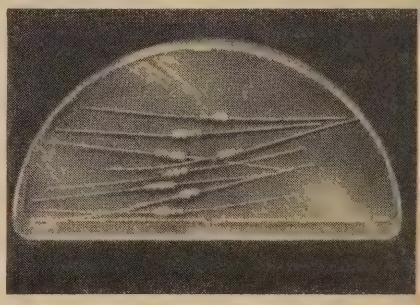
Tune in a station and connect a wire from the floating lug to a metal window frame or any type of an antenna that is not grounded. Adjust the added variable capacitor (use a knob on its shaft), and the receiver will all but jump from its stand. The knob prevents body capacitance from affecting the capacitor setting.—*George E. Lytle*

KEEP FUSES HANDY

It's a good idea to store a couple of replacement fuses in TV line amplifier boxes. By taping a couple to each amplifier's chassis, you may save yourself a trip back to the service truck or shop for a replacement fuse of the needed size.—*John A. Comstock*

HANDY PARTS BIN

Save those empty plastic cheese containers. They have many uses around the workshop. The containers come packed with wedges of cheese, but after they are removed, the container and its tight-fitting lid are left. Both container

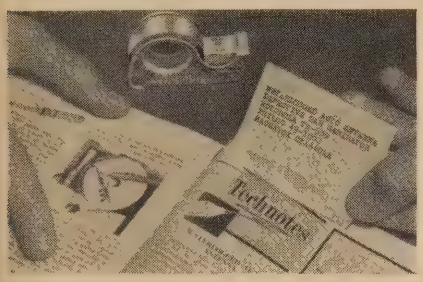


and lid can be used as parts bins or they can be used to keep all the parts for a single project together. When you build a kit, put all the resistors in one container, all the capacitors in another, etc. There is no end to the uses for these versatile boxes.—*Ronald Newbower*

KEEP TABS ON TECHNOTES

Every time I receive my monthly copy of RADIO-ELECTRONICS, I turn to the Technotes section, observe the make and model number of each set mentioned (or the title of each topic) and type them down on a small slip of paper. I then attach the paper to the top of the page near the centerfold with a piece of plastic tape.

Whenever a set comes in with unfamiliar troubles, I check through all of the tabs protruding from my copies of R-E to see if the set or trouble has

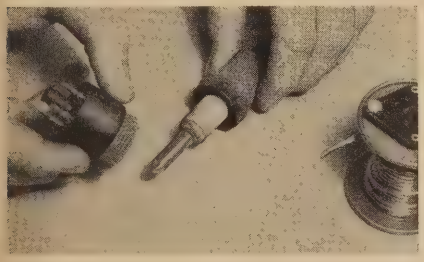


been listed. Many a time, Technotes have saved me wasted hours of work trying to pinpoint a trouble.—*J. A. Comstock*

(They are also indexed in the Annual Index appearing in the December issue each year, as are all articles.—*Editor*)

SOLDERING-IRON CLEANER

To make a handy soldering-iron-tip cleaner, roll up a length of 2-inch wide wire screen and force-fit it into the



bakelite base of an old octal tube. When the cleaner isn't in use, store it in an old octal tube socket attached to the top of your spool of solder.—*John A. Comstock*

SOLDER DISPENSER

A small medicinal bottle or five and dime store plastic vial makes a handy solder dispenser for the toolkit, convenient and easy to use. Just wind a coil of solder around a pencil or other form, and drop it into the bottle. Punch a small hole in the bottle's lid and thread the solder out through it. Pull out more solder as needed while soldering.—*Charles A. Cunningham* END

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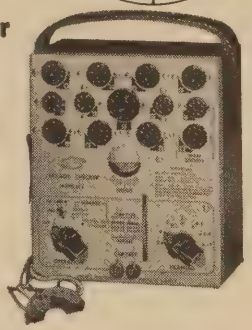

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(Continued on p. 137)

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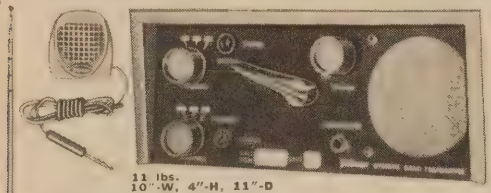

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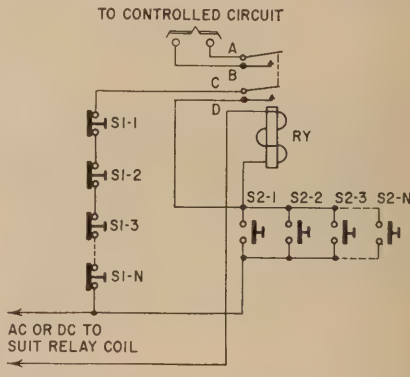
The latching action requires only a momentary operation of a pushbutton to latch, and another push to reset or

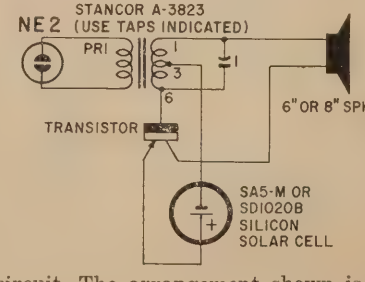


unlatch. An added advantage of this hookup is that only three wires need be run for the installation of as many control positions as may be required or desired.

Here's how the circuit works: When S2 is closed momentarily, the relay coil is energized and contacts A–B and C–D close. Since S1 is normally closed, the closing of contacts C–D bridges S1 and the relay coil remains energized when S2 opens. A momentary operation of S1 now de-energizes the relay coil, opening C–D and unlatching the circuit.—*Robert E. Monroe*

SUN-POWERED OSCILLATOR

This one-transistor 400-cycle oscillator is powered by a single solar cell. Almost any transistor will work in this



circuit. The arrangement shown is for p-n-p types. For n-p-n transistors, reverse the solar cell.

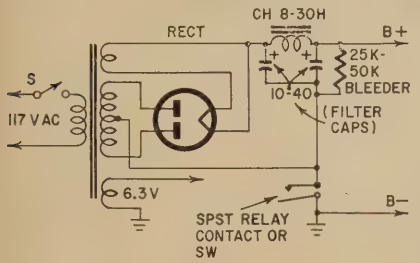
A neon lamp is connected so it will

glow whenever the transistor oscillates. This makes the circuit a transistor checker. Plug in a good transistor and the lamp lights. Plug in a bad one and nothing happens.

By using a 100-watt lamp as the light source, you can get a rough approximation of the transistor's gain. A very good transistor will oscillate when the lamp is 30 inches from the solar cell. Less sensitive units will not oscillate until the lamp is brought closer to the solar cell and voltage increases.—*G. L. Garvin*

FASTER BREAK-IN

Both the receiver and transmitter in many ham or Citizens-band setups have a slow recovery time from receive to transmit and vice versa. Lots of receivers and transmitters are wired so that the center tap of the power transformer is broken, and the filter capacitors and bleeder resistor are left in the circuit



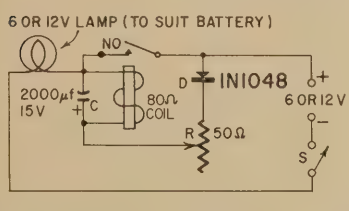
to drain off through the B-plus line. The transmitter vfo and some crystal oscillators use this type of circuit.

By breaking the center tap with the minus side of the filter capacitors and the bleeder resistor connected direct to the center tap, this condition is improved from 75% to 100% in all cases tried. A spst relay contact or switch is used to break this connection.—*George P. Oberto, K4GRY*

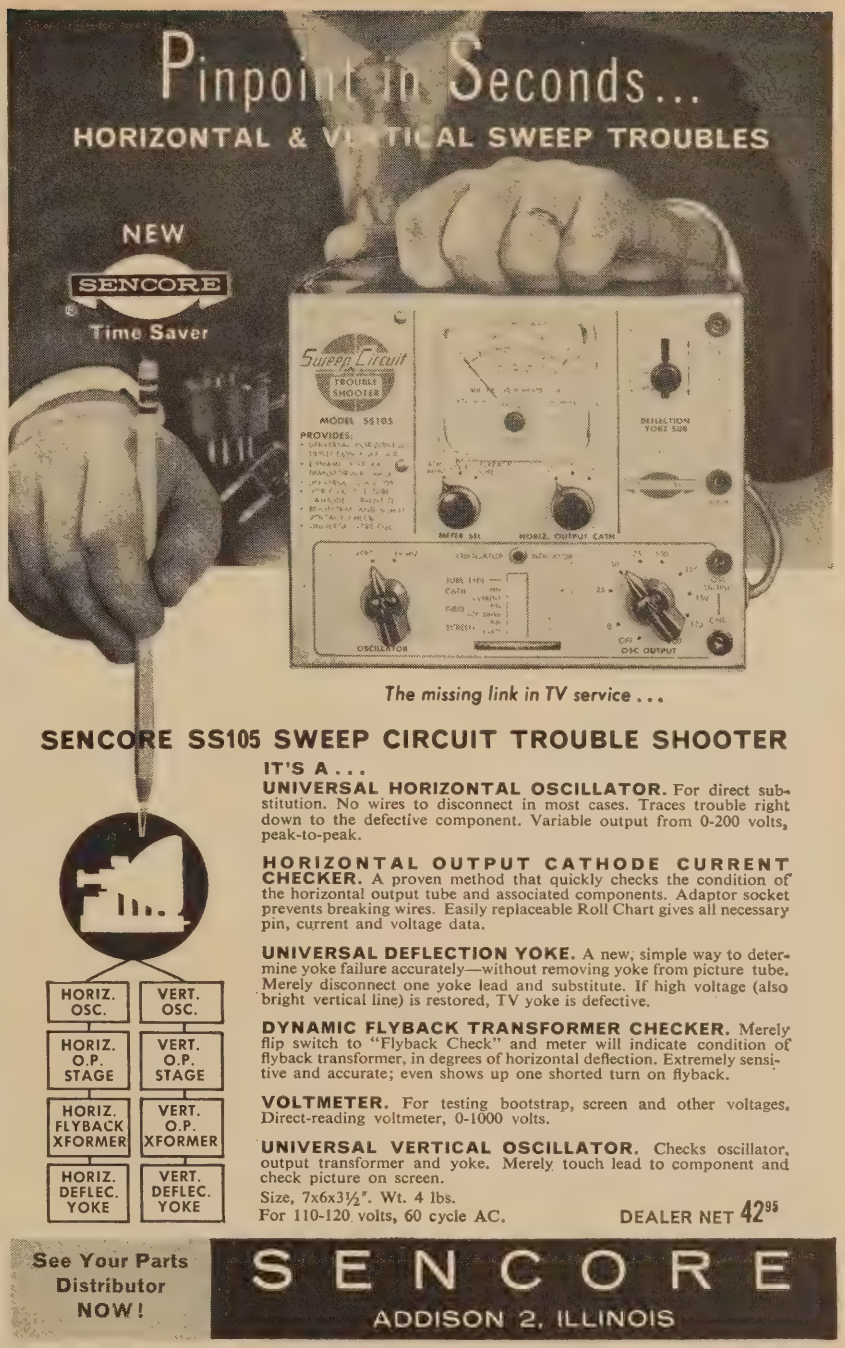
LIGHT BLINKER

This simple circuit is a blinker whose time interval is adjustable. As it works off 6- or 12-volt batteries, it could be set up as a warning device for your car. Should you get stuck at night, just plug it into the cigarette lighter and set it up on the road behind your car.

When switch S is closed, turning the



unit on, the capacitor charges and closes the relay, lighting the lamp. The diode keeps the capacitor from being shorted by the relay contacts and the light remains lit until the capacitor discharges through potentiometer R and the relay coil. Then the relay opens, the light goes out and the whole sequence repeats itself.—*L. George* END



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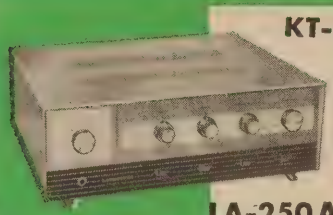

KT-250A

IN KIT FORM **74.50**

LA-250A 99.50
COMPLETELY WIRED

50 WATT INTEGRATED STEREO AMPLIFIER

● RESPONSE 17-21,000 CPS ± 1 DB (at normal listening level) ● UNIQUE "BLEND" CONTROL ● PREMIUM EL86 OUTPUT TUBES ● 50 WATTS MONAURAL—25 WATTS EACH STEREO CHANNEL. ● CLUTCH-OPERATED VOLUME CONTROL ● SEPARATE BASS & TREBLE CONTROLS

A completely new stereo high fidelity amplifier with a high quality of reproduction, remarkable versatility and new distinctive styling. Full range of controls include a unique "blend" control for continuously variable channel separation—from full monaural to full stereo, 4-position Selector, Mode, Loudness and Phasing switches plus outputs for 4, 8 or 16 ohm speakers. Harmonic distortion less than 0.25%, IM distortion less than 1%. Hum and Noise 74 db below full output. Assembly is simple—no special skills or tools required. Complete with deluxe cabinet and legs, all parts, tubes and detailed instruction manual. Shpg. wt., 26 lbs.

KT-250A WX Stereo Amplifier Kit ..... 5.00 Down ..... Net **74.50**
LA-250A WX Stereo Amplifier, wired & tested .... 5.00 Down ..... Net **99.50**

KT-600

IN KIT FORM **79.50**

LA-600 134.50
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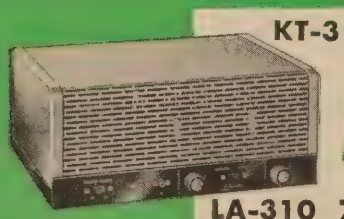
PROFESSIONAL STEREO CONTROL CENTER

● RESPONSE 5-40,000 CPS ± 1 DB ● UNIQUE STEREO & MONAURAL CONTROL FEATURES ● PRECISE "NULL" BALANCING SYSTEM ● CONCENTRIC INPUT LEVEL CONTROLS

A truly professional stereo preamplifier and master audio control center—solves every stereo monaural control problem. Features unique Bridge Control for variable cross-channel feed for elimination of exaggerated channel separation effects—plus controlled 3rd channel output. Has all-concentric controls—including clutch-operated Volume Balance control. Provides complete and advanced facilities for accepting, controlling and providing undistorted gain for any and all program sources. Sensitivity 2.2 mv for 1 volt out (low level inputs). Dual low impedance "plate follower" outputs 1500 ohms. Response 5-40,000 cps ± 1 db. Less than .03% IM distortion. Less than .1% harmonic distortion. Hum and noise 80 db below 2 volts (high level inputs). Uses 7 new 7025 low-noise dual triodes. Size: 14" x 4½" x 10⅜". Shpg. wt., 16 lbs. Complete with all parts, tubes, deluxe cabinet and detailed instruction manual.

KT-600 WX Stereo Preamplifier Kit ..... 5.00 Down ..... Net **79.50**
LA-600 WX Stereo Preamplifier, wired and tested ..... 5.00 Down ..... Net **134.50**



KT-310

IN KIT FORM **47.50**

LA-310 72.50
COMPLETELY WIRED

STEREO/MONAURAL POWER AMPLIFIER KIT

● 36 WATT STEREO AMPLIFIER—18 WATTS EACH CHANNEL ● EMPLOYS 4 PREMIUM-TYPE 7189 TUBES ● 2 PRINTED CIRCUIT BOARDS FOR SIMPLIFIED WIRING ● RESPONSE BETTER THAN 35-30,000 CPS ± ½ DB AT 18 WATTS ● LESS THAN 1% HARMONIC OR IM DISTORTION

A superb basic stereo amplifier in easy-to-build kit form. Unit may be used with a stereo preamplifier to provide two 18 watt stereo channels or, at the flick of a switch, as a fine 36 watt monaural amplifier. Controls include 2 input volume controls, Channel Reverse switch and Monaural-Stereo switch. Dual outputs for 4, 8, 16 or 32 ohm speakers. Input sensitivity .45 volts per channel for full output. Tubes are 2-6AN8, 4-7189, GZ-34 rectifier. Size 10-9/16" d x 5¼" h x 13¼" w. Complete kit with cage, all parts, tubes and detailed instruction manual. Shpg. wt., 22 lbs.

KT-310 WX Stereo Power Amplifier Kit ..... 2.00 Down ..... Net **47.50**
LA-310 WX Stereo Power Amplifier, wired and tested ..... 5.00 Down ..... Net **72.50**

KT-500

IN KIT FORM **74.50**

LT-50 124.50
COMPLETELY WIRED

FM-AM STEREO TUNER KIT

● 11 Tubes (4 dual-purpose) + Tuning Eye + Selenium rectifier provide 17 tube performance ● Multiplex Output for new Stereo FM ● Armstrong Circuit with Dual Limiters and Foster-Seeley Discriminator ● Extreme Sensitivity and Wide Frequency Response.

A precision engineered, highly stable tuner—perfect for lifelike stereo FM-AM broadcast reception, FM reception and/or AM reception. Features separate tuning and volume controls for AM and FM. Magic eye on AM and FM, plus automatic frequency control on FM for accurate tuning—stations are "locked" in. Other deluxe features include cathode follower outputs and 5-position Function Selector. Efficient, broadband circuitry on AM with built-in antenna. FM section features include 2 microvolts sensitivity for 30 db quieting, frequency response 20-20,000 cps ± ½ db and full 200 KC bandwidth. Two printed circuit boards make wiring simple—even for such a complex unit. Complete kit includes all parts, deluxe cabinet and detailed instruction manual. Size is 13¾" W x 10⅜" D x 4½" H. Shpg. wt., 22 lbs.

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LT-50 WX Same as above, wired & tested ..... 5.00 Down ..... Net **124.50**

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KT-236A

IN KIT FORM **59.50**

LAFAYETTE 36-WATT INTEGRATED STEREO AMPLIFIER KIT

● 36-WATTS MONAURALLY—18 WATTS PER CHANNEL ● FREQUENCY RESPONSE 15-30,000 CPS ± 1 DB ● UNIQUE "BLEND" CONTROL ● CONCENTRIC CLUTCH-OPERATED VOLUME CONTROL ● DUAL CONCENTRIC BASS AND TREBLE CONTROLS ●4-EL84 TUBES IN PUSH PULL

This exciting new amplifier kit combines dual preamplifiers and dual 18 watt power amplifiers on one compact chassis. Instant selection from monophonic to stereophonic is provided by the turn of a switch. An amazing new "Blend" control gives continuously variable channel separation from full monophonic to full stereo. The concentric clutch-operated volume control offers independent or simultaneous level adjustments of both channels. Dual concentric bass and treble controls furnish 4 independent tonal adjustments. Harmonic distortion less than 0.15% at normal listening level. I.M distortion is less than .3%. Hum and noise 70 db below rated output. Complete with cage, legs and detailed instructions. Shpg. Wt., 24 lbs.

KT-236A WX Stereo Amplifier Kit ..... 5.00 Down ..... Net **59.50**

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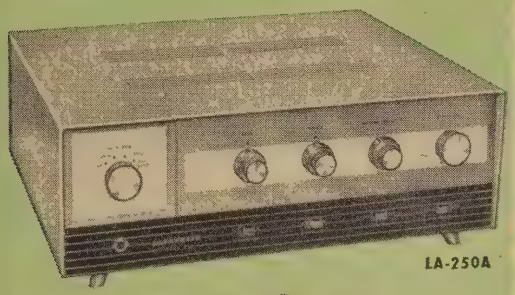
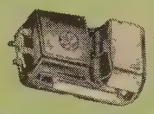
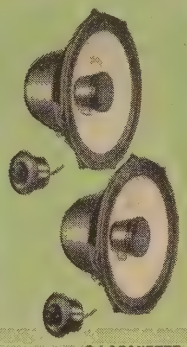
NEW! Lafayette 50 Watt Complete Stereo Phono System


LA-250A

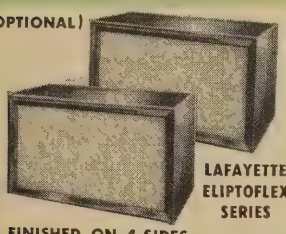

NEW GE VR-227

GARRARD RC121/11

WOOD BASE


2-LAFAYETTE SK-58

(OPTIONAL)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214-318	Indoor—60 mil, 7 28 pure copper conductors	x	x	x	x
214-056	Standard—60 mil, 7 28 pure copper conductors	x	x	x	x
214-559	Steelcore—72 mil, 7/28 copperweld conductors		x	x	x
214-298	Rotator—4 7/28 pure copper conductors		x	x	x
214-100	Century—100 mil, 7/28 pure copper conductors		x	x	x

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214-271	Air Core—U.S. Pat. 2543696, 7/28 pure copper conductors	x	x	x

AMPHENOL **DISTRIBUTOR DIVISION**
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BUSINESS and PEOPLE

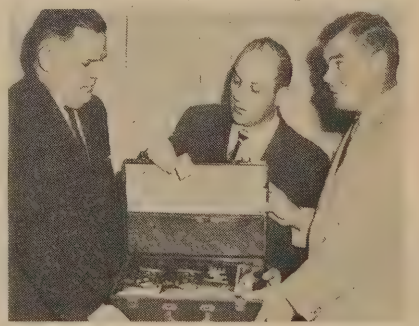
Sprague Products Co., North Adams, Mass., designed a window–wall poster for service technicians, captioned "Every Day Is Independence Day" to increase prestige with the consumer.

G–C Electronics, Division of Textron, Inc., Rockford, Ill., is offering TV service technicians free chemicals during the month of March in two special 2-for-1 offers. A can of G-C Spra-Kleen TV tuner cleaner is available free with the purchase of a can of G-C Zero-Mist Spra-Koat. In the other offer, a bottle

of G-C De-Ox-Id cleaner is offered free with the purchase of a bottle of G-C Red-X-High Voltage Corona Dope. The offer is being advertised in the March issue of RADIO–ELECTRONICS and other trade publications.

John F. Rider Publisher, New York, designed a wall display for service technicians aimed at building consumer confidence in the service-shop operation.

Electro-Voice, Inc., Buchanan, Mich., launched one of the strongest promotional campaigns in its history to introduce its new model 644 Sound Spot microphone. The company also designed a needle sales kit for its representatives following its entry into the phonograph

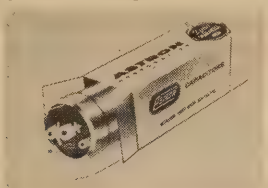


needle business. Larry LeKashman, Electro-Voice vice president–marketing (center), and C. E. "Pete" Seaman, product manager (right), are shown explaining the kit to Harrison Blind, Indiana representative.

Sencore, Addison, Ill., celebrates its 10th anniversary this year. From very modest beginnings 10 years ago, it has grown to a leading position in the service test-equipment field. The company held a sales meeting recently to outline plans for 1960. Ed Flaxman, sales vice president (right), is shown explaining a production operation to the company's representatives.

Electronic Instrument Co., Inc., Long Island City, N. Y., recently played host to the management and sales personnel of Parts Unlimited, metropolitan New York distributor chain, in a tour through the EICO factory. Photo shows Harry R. Ashley, EICO president, addressing the group.

Astron Corp., East Newark, N. J., is packaging its new Red Seal twist-prong and Minimite electrolytic capacitors in distinctive new functional packages. The company also designed a metal mer-

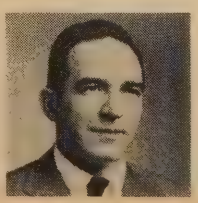


chandise display cabinet for the capacitors, and backed them with the industry's first 2-year performance guarantee.

Robert J. Reigel (left), was appointed merchandising sales director of Cornell-Dubilier Electric Corp., South Plainfield, N. J., as part of the company's new expansion program. He had been with Thordarson Meissner and Chicago

Standard Transformer Co. **Arthur Williams,** sales manager of the Original Equipment Manufacturers Div., was named commercial products sales director, and **Glenn M. Ronk,** formerly with American Electronics, Inc., joined Cornell-Dubilier as military and industrial sales director.

Mario A. DeMatteo joined Pyramid Electric Co., Union City, N. J., and Darlington, S. C., as general sales manager. He comes from **Astron Corp.,** where for the past 8 years he was most recently assistant general sales manager and previously held the position of distributor sales manager.



Arch Warden was elected president of Xcelite, Inc., Orchard Park, N. Y. He had been vice president in charge of sales, and will continue as sales manager. He replaces **F. Birney Farrington,** founder of the company, who retired.

Don Hughes, former advertising and sales promotion manager, was named to head the newly consolidated sales promotion and merchandising activity of Sylvania Electronic Tubes, New York. **Samuel J. McDonald,** eastern regional distributor sales manager, has been appointed assistant manager of the distributor sales department.

Harold F. Cook has been named sales planning manager of Tung-Sol Electric, Inc., Newark, N. J., and **Robert E. Bilby** becomes advertising and sales promotion manager. Cook, who has been with Tung-Sol for over 25 years, was most recently manager of marketing services, and Bilby, supervisor of sales analysis and controls.

Rod Kershenstein is general sales manager of Glaser-Steers Corp., Newark, N. J. He joined the company from Ampex Corp., where he was eastern district marketing manager.

END

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TUBE TESTER ROUTE OPERATORS

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"QUALITY BRAND"
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Six-channel operation. Choose up to 6 channels, by means of an illuminated front panel selector. The dial is direct reading – no interpolation needed.

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No retuning – the Transpace maintains full sensitivity and power output when you switch channels.

Rugged construction–withstands the roughest mobile use. Super-tough vinyl finish.

Immediate delivery from stock. Write for literature and name of local dealer.

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CITIZENS BAND 27 MC ANTENNA

DESIGN permits rapid mounting similar to that used for TV antennas—on 1¼" masting, tubing, chimney mounts, sidewall brackets, etc.

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FINEST CONSTRUCTION: All aluminum seamless tubing, with weatherproof UHF coaxial connector. Aluminum casting main support. Weighs only 2 lbs., 14 oz. Overall height a full 17' 6".

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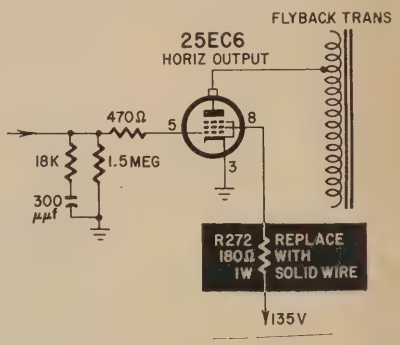
Technotes

G-E 14P1210

Complaint: Insufficient width.
Cure: Replace R272 (180 ohms, 1 watt) with a short length of wire. This provides more drive and therefore a wider picture. — *Larry Steckler*



AUTO RADIO HINT

When an automobile radio gives continual trouble—frequent tube replacement, vibrator replacement, etc., it is a good idea to check the car's electrical system voltage. Connect a voltmeter to the power lead that goes to the radio and run the engine faster than idle so the battery is charging. For a 6-volt system, voltage should measure between 7.0 and 7.5. For a 12-volt system, voltage should measure between 14 and 15. If it is higher or lower, advise the owner to have the generator and regulator checked.—*Charles Erwin Cohn*

USING SQUARE WAVES

A square wave is good for making a rough check of amplifier frequency response. If the square wave at the amplifier's output looks almost as square as the wave at the amplifier's input, the test shows that the amplifier has a reasonably flat response.

The square wave's fast rise time represents a high frequency because it

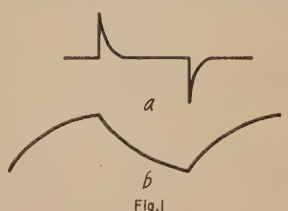


Fig. 1

is a quick change from no voltage to full voltage. If the amplifier cannot pass such a fast rise, it cannot pass high frequencies. The flat top of the square wave represents low frequencies because the duration of the flat top is relatively long. In short, the leading edge of the square wave is the high-

frequency component, the flat top and trailing edge are the low-frequency components.

Many waveshapes are possible at the output of a defective amplifier. Fig. 1 shows extreme cases. In *a* there is an extreme loss of lows; in *b*, an extreme loss of highs. In practice, severe frequency distortion can be detected by

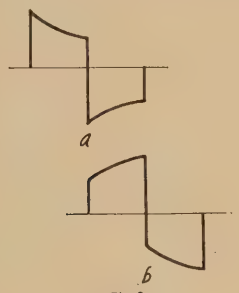


Fig.2

ear. The practical use of square-wave testing is to reveal small amounts of peaking at high frequencies (Fig. 2-a) or small losses at high frequencies (Fig. 2-b). This shows up as a rounding of the square wave's leading edge.

When making square-wave checks, adjust the tone controls for the squarest wave you can get. Also don't forget to consider the limitations of your scope and generator when analyzing the waveform seen on your scope. Always check generator output first so you know what the output waveform should look like.—*W. C. Warren*

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Adjust the contrast for a dark picture and set the background controls to make the brightest parts of the picture as white as possible.

Then turn all screen controls to maximum and reduce brightness to eliminate the resulting blooming.

Last, reduce the screen controls until the dark areas are nearly black.—*C. S. Lawrence*

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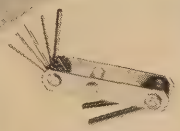

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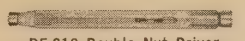

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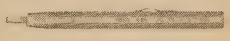

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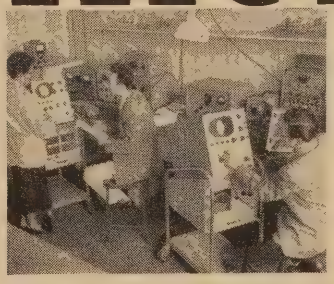

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BASIC ELECTRONICS, by Bernard Grob. McGraw-Hill Book Co., Inc., 330 West 42 St., New York 36, N. Y. 6 x 9 in. 524 pp. $9.25.

This good book for beginners covers the basic principles of dc, ac and magnetism clearly and without recourse to math. Circuits, components and instruments are analyzed as the reader is prepared for more advanced study.

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HI-FI MADE EASY, by Norman Crowhurst. Gernsback Library, Inc., 154 W. 14th St., N.Y. 11, N.Y. 5½ x 8½ in. 224 pp. $2.90

This popular subject is explained in popular manner by a well known authority. In readable and understandable style, he tells what hi-fi is and how to enjoy it. Everything is clearly explained with humorous cartoons to illustrate the definitions, techniques and comparisons.

Each of the nine chapters discusses a different component or topic, such as distortion, pickups, woofers, stereo. One will find the meaning of db, how to set up for stereo, how to choose components, etc. If you think hi-fi books must be technical, you haven't seen this one. —*IQ*

AUTO RADIO MANUAL (Vol. 8, Series AR-8), 8½ x 11 in., 240 pp. $3.95. RECORD CHANGER MANUAL (Vol. 12, Series RC-12), 8½ x 11 in. Pages not numbered. $2.95. Howard W. Sams & Co., 2201 E. 46th St., Indianapolis 6, Ind.

These two manuals are the latest in the continuing series on auto radios and record changers. The auto radio manual provides complete Photofact service data on 1957–58 sets of 16 makes or brands. RC-12 provides Photofact coverage of 61 automatic record changers and an electronic drive turntable made in 1958-59.

ALGEBRA OF ELECTRONICS, by Chester H. Page. D. Van Nostrand Co., 120 Alexander St., Princeton, N.J. 6 x 9½ in. 258 pp. $8.75.

MATHEMATICS FOR COMMUNICATION ENGINEERS, by S. J. Cotton. Macmillan Co., 60 Fifth Ave. N.Y. 11, N.Y. 6½ x 10 in. 245 pp. $7.50.

MATHEMATICS DICTIONARY, edited by Glenn James and Robert C. James. 6 x 9 in., 546 pp. $15.

These three recent books each fill a different need. *Algebra of Electronics* has been written with the less advanced student or worker in mind; the explanations are detailed and the text easy to read. *Mathematics for Communication Engineers* is aimed at the practising engineer or the advanced engineering

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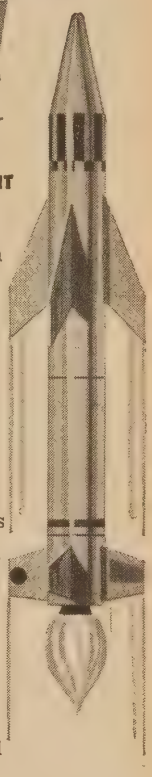

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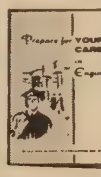

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BASIC AUDIO (3 volumes), by Norman H. Crowhurst. John F. Rider Publisher Inc., 116 W. 14 St., N.Y. 11, N.Y. 6 x 9 in. 349 pp total. $2.90 each.

A three-volume set that starts with the nature of sound and ends with stereophonic sound. Almost every page is illustrated and nowhere does the author go off into complicated theory. Each chapter is followed by a group of questions, so the reader can tell just how well he has absorbed the content of a particular section. As a whole, the set is an interesting way of presenting a technical subject in a nontechnical manner.—*LS*

DIGITAL COMPUTER PRIMER, by E. M. McCormick. McGraw-Hill Book Co., Inc., 330 W. 42nd St., N.Y. 36, N.Y. 6 x 9 in. 214 pp. $7.50.

This book is for the mathematically sophisticated layman. It explains the workings of a computer, and discusses coding, logic, control, storage and programming. The organization of a tick-tack-toe machine is described as an example.

In the appendix one reads that of a total of 57,936 words in the original manuscript of this book, 57,634 have 13 letters or less, and 1,420 words appear but once. You guessed it—a computer disclosed these facts!—*IQ*

TUBE REPLACEMENT GUIDE (Expanded Edition), H. G. Cisin. Harry G. Cisin, Publisher, Amagansett, N.Y. 5½ x 8½ in., 49 pp. $1

A listing of over 2,700 substitutes for more than 1,500 receiving type tubes, 325 picture tube substitutions, US equivalents and substitutes for over 240 foreign tubes. The concluding section covers transistor equivalents and replacements for use in popular transistor radios. All tube substitutions can be made without socket changes or rewiring.

SOUND IN THE THEATRE, by Harold Burris-Meyer and Vincent Mallory. Radio Magazines, Inc., Mineola, N.Y. 8½ x 10¼ in., 95 pp. $10.

Appropriate sound effects and illusions can greatly enhance a stage or concert presentation. These authors have had extensive experience in the *control* of sound (as distinct from mere amplification). Their techniques apply to Broadway theaters, concert halls, open-air amphitheatres, night clubs, etc.

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SOLID STATE MAGNETIC AND DIELECTRIC DEVICES, edited by H. W. Katz. John Wiley & Sons, Inc., 440 Fourth Ave., N.Y. 16, N.Y. 5¾ x 9 in. 542 pp. $13.50.

Computers, filters and transformers are among modern devices that make use of ferrites and titanates. *Solid State Magnetic and Dielectric Devices* discusses the theory, construction and applications of these devices.

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INTERNATIONAL RECTIFIER CORP. ENGINEERING HANDBOOK, International Rectifier Corp., El Segundo, Calif. 7 x 9 in. 128 pp. $1.50.

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TRANSDUCTORS AND MAGNETIC AMPLIFIERS by A. G. Milnes. St. Martins Press, Inc., 103 Park Ave., N.Y. 17, N.Y. 7 x 9¾ in. 286 pp. $12.50.

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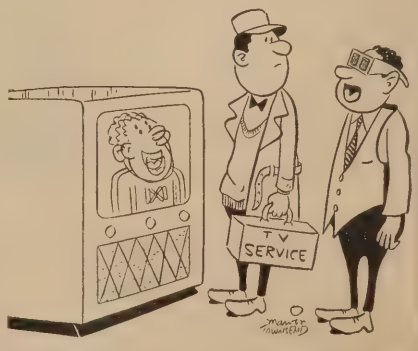

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Aerovox Corp. 128
Airex Radio Corp. 112
Alco Electronics Mfg. 112
Allied Radio Corp. 17, 75, 96-99
American TV & Radio Co. 70
Amperex Electronic Corp. 14
Amphenol-Borg Electronics Corp. 140
Arkay International Inc. 22
Astatic Corp. ..... Inside Back Cover
Atlas Sound Corp. 106
Audax Division of Rek-O-Kut 112
Audion 126

B & K Mfg. Co. 71, 129
Barry Electronics Corp. 148
Bonafide Radio 117
Brooks Radio & TV Corp. 136, 144
Burroughs Corp. 18
Burstein-Applebee 101

CBS Electronics 26
Capitol Radio Engineering Inst. 84-87
Carston Studios 93
Castle TV Tuner Service 116
Centralab Div. of Globe Union 16
Century Electronics Co. Inc. 102-103
Charles Engineering Co. 123
Cleveland Institute of Radio Engineering 11
Colordaptor 113
Columbia Record Club 13
Commissioned Electronics Co. 132
Communications Associates Inc. 137
Coyne Electrical School 116, 119, 134

DeVry Technical Inst. 7
Dressner 101
Duotone 116

Electro-Sonic Labs 134
Electronic Chemical Corp. 81
Electronic Instrument Co. 31, 32
Electronic Measurement Corp. 94
Electronic Publishing Co. 142
Electro-Voice, Inc. 82-83
Esse Radio Co. 126
E-Z Hook Test Prods. Co. 127

General Cement Mfg. Co. 105
General Electic Co. 24-25
Gernsback Library 146
Glaser-Steers Corp. 100
Grantham School of Electronics 15

Heald Engineering College 143
Heath Company 67-69
Hi-Fidelity Centre 131
Hi-Par Products 142
Homewood Industries 127

Illinois Condenser Co. 132
Indiana Technical College 131
Institute of Radio Engineers 130
International Resistance Corp. 71

JFD Electronics 115
Jensen Industries 106
Jensen Mfg. Co. ..... Inside Front Cover

Kedman Co. 127
Key Electronics Co. 93

Lafayette Radio 138-139

Moss Electronics 90-91

National Radio Institute 27-28, 113
National Technical Schools 5
North American Phillips Co. 104

Olson Radio Corp. 134
Opportunity Adlets 135, 137

Paco Electronics Co. 12
Philco Techrep Div. 150
Picture Tube Outlet 132
Planet Sales Corp. 93
Progressive "Edu-Kits" Inc. 120

Quam-Nichols Company 81
Quietrole Co. 100

RCA Electron Tube Div. ..... 77-79, Back Cover
RCA Institutes 19
Radio-Electronics Master 113
Radio Shack Corp. 136
Rad-Tel Tube Co. 121
Rek-O-Kut Co. 112
Remington Rand Univac 122
John F. Rider 149
Rinehart & Co. 108, 126, 132
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Sams & Co. (Howard W.) 124, 125
Seg Electronics 133
Sencore 131, 133, 135, 137
Shure Brothers, Inc. 22
Sonotone Corp. 80
Sprague Products Co. 107
Sprayberry Academy of Radio TV 23
Standard Coil Products Co. 29
Sylvania Electric Products 8

TAB 126
Tarzian (Sarkes), Inc. 136
Telectrosonic 10
Teltron Electrical Co. 145
Thorens Co. 3
Transpace 142
Turner Co. 118

Vaco Products Co. 143
Vanguard Electronic Labs 100
D. Van Nostrand Co., Inc. 9, 114
Vidaire Electronics 117

Weller Electric Corp. 117
Westinghouse Electric Corp. 20-21
Weston Electrical Instrument Corp. 111

John Wiley & Sons, Inc. 106
Winegard Company 73
Wuerth Tube Saver Corp. 101

Zalytron Tube Co. 141

SCHOOL DIRECTORY PAGE 147

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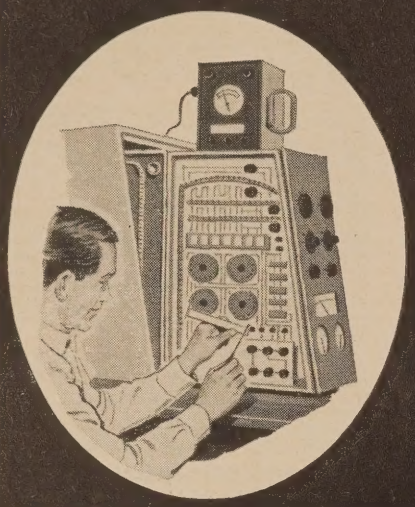

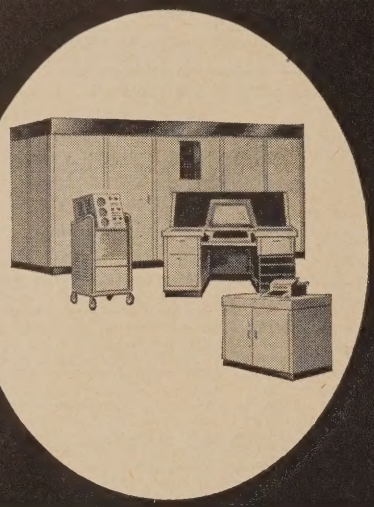

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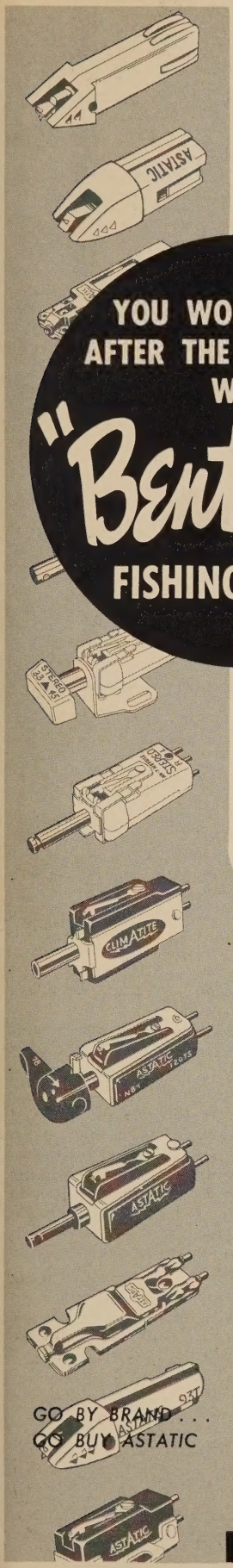

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